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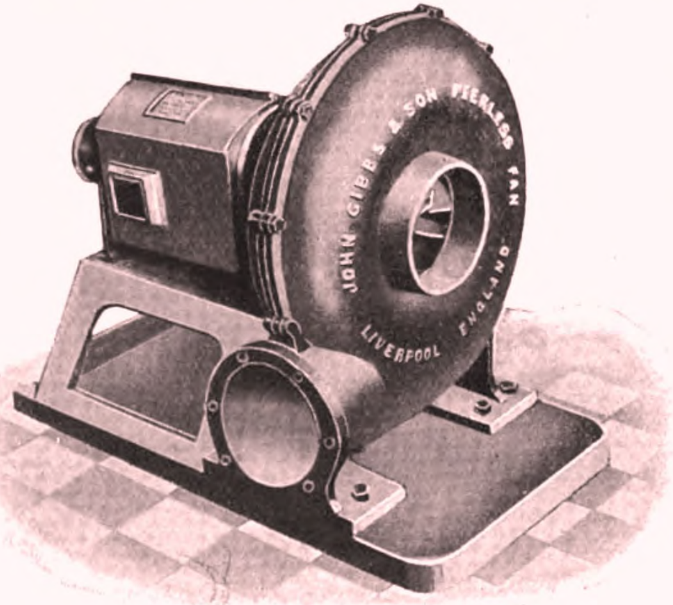
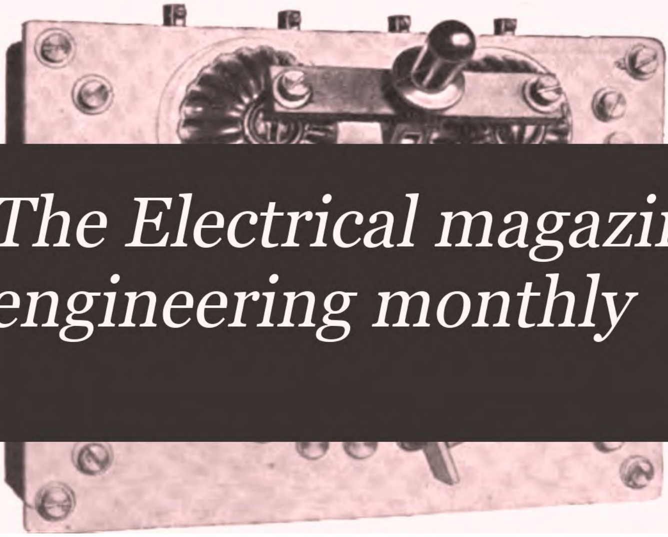
The Electrical magazine and engineering monthly

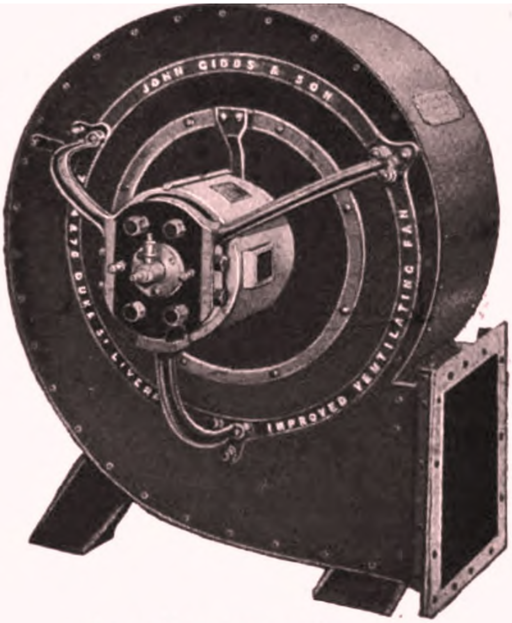
guard the motor under all conditions of load, and render the switch as perfect as is humanly possible for preventing damage to the motor. Messrs. John Gibbs & Sons have also recently completed an order for the British Admiralty for their patent fans with improved type water-tight cases, the joints of the case being made absolutely waterproof, and a gland and sprayer fitted at front end of motor to



Gibbs' Peerless Blower.

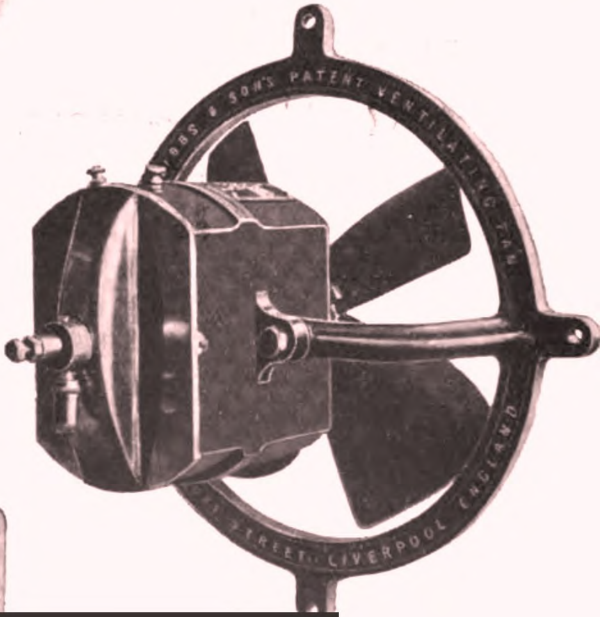
prevent either oil or water getting into the motor case. In addition to certain minor improvements in the manufacture of fan driving motors tending to furnish greater durability, a direct driven electrical "Peerless" blowing fan has been introduced, with the evidence of the efficiency of which, as





Gibbs' Ventilating Blower.

reported in various testimonials from customers, the company states it has every reason to be gratified. In


GIBBS & SON'S PATENT VENTILATING FAN
STREET, LIVERPOOL ENGLAND

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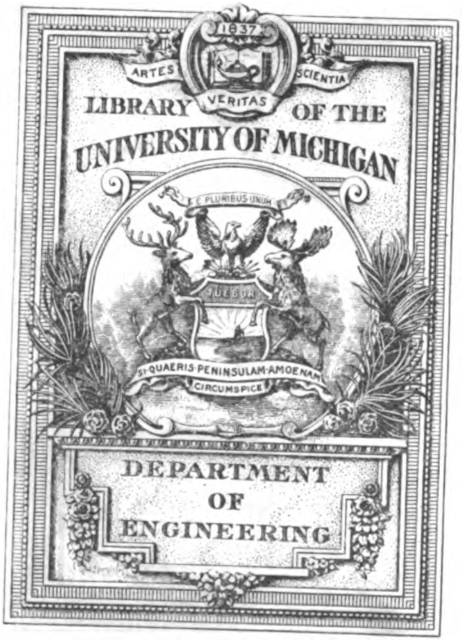
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Popular Electricity.

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The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. V. No. 1. (25th Issue.) LONDON. JANUARY 31, 1906.

We have done much

during the past year to improve the prestige and increase the standing of THE ELECTRICAL MAGAZINE among high-class electrical journals. As a reflex of electrical thought, investigation and development the world over, it stands alone. As a specific publication appealing to a scientific, commercial, and industrial community, it occupies a practically unique position both from the nature of its contents and its business-producing qualities.

The Magazine inaugurates its third year with an entirely new programme. From now onwards this journal will present the embodiment of an ideal which we have been aiming for, and which we are sure will irresistibly appeal.

We also enter the field to-day, on this our second anniversary, with a novel departure which will come in the nature of a surprise to our numerous readers—a pleasant surprise, doubtless, particularly when the objects, aims, and aspirations of the innovation become manifest. We refer to the advent of the new journal—POPULAR ELECTRICITY—which we are publishing this month, and a copy of the initial issue of which is presented herewith.

It starts unpretentiously as regards size, but we have purposely avoided bulk; the average man has not time to read daily volumes, he wants terse, informative matter. What it lacks in pages it will make up in interest and circulation. In addition to a copy being presented with every issue of THE ELECTRICAL MAGAZINE, a considerable number have been printed to meet special requirements in every part of the United Kingdom. In this connection we are receiving extraordinary co-operation from influential bodies, and have aroused an interest which will ensure most effective service, which will greatly redound to the advantage of readers and advertisers alike.

THE ELECTRICAL MAGAZINE and POPULAR ELECTRICITY will work hand-in-hand. Both have a specific mission. By enthusiastic, concerted effort, intelligently directed and forcefully applied, with the means at hand to effect our purpose, and with the co-operation of those whose material interest it is to see that the advantages of electricity are made manifest to all and sundry, we have no fear but that we shall be able to carry out our big programme with signal success in the interests of all our supporters.

Our best thanks are due to all those who have supported this paper in the past. Our increasing subscription list, containing names of men in every part of the globe, is evidence of appreciation and of the Magazine's utility. We can promise our readers that in 1906 we shall place in their hands a journal which, both in point of interesting contents and commercial value, will be an advance upon anything yet accomplished.

RETROSPECT AND PROSPECT, 1905-6.

In again reviewing a year's record of electric progress it is an even more pleasurable task than at this time twelve months ago devolved upon us. Every sphere of electrical activity returns striking evidence of continued progress and genuinely constant expansion such as gives high hopes of something approaching a boom in the near future. Trade developments have now reached into the most remote countries of the world, and distance is no longer a barrier to either sales or construction work on sites thousands of miles from the factory. The marketing of electrical apparatus is at the moment a matter requiring the strictest organization, as the field to be covered is broadened to an extent which demands proper direction of effort if a remunerative connection is to be built up. In this regard we are at the moment excelled by our American and Continental neighbours, who succeed in placing their goods in our Colonies under the very nose of British agents. Colonial trade, however, presents encouraging prospects for home makers, and the year's record brings abundant testimony of this.

If we are to expect a boom in any branch of electrical enterprise it will take place in that represented by electricity supply. The Olympia Exhibition gave a fillip to trade which will carry it forward for a year at least, and once momentum is gained—for it assuredly will be—we can expect to make even more substantial impression on the opposition of the gas interest. Electric lighting has made rapid strides during the year, and the new incandescent lamps, though costly, are finding favour on all sides. Whatever representations the gas people may make in favour of their particular illuminant, they will never shake public confidence in electricity. That is now too firmly established. Arc lighting can boast of great advances and an increased degree of support from light users of every class. In street lighting, the flame arc bids fair to sweep out gas entirely, and it will certainly be better appreciated when the underhand tactics of gas advocates are exposed. Our gas rivals should come out into the open and fight the battle like men.

The field of electric traction has widened considerably during the year. At its opening we looked forward to material progress with alternate-current apparatus, and events have more than exceeded our anticipations. Tinkering with small motors and trucks has given place to constructive work on heavy equipments, and the performance of these prompted immediate developments with even larger tractive units. Viewed broadly main line electric traction may be approached from three distinct standpoints: that of direct current, that of alternate-current one-phase, and that of alternate-current three-phase. At the close of the year there were evidences of attempts to bring direct-current voltages into competition with alternate current, and these will doubtless be pushed further, but at the moment of writing the alternate-current advocates certainly have a good headway which they should be able to maintain. One-phase lines are more numerous than three-phase, and the coming year will certainly see their number added to, but the competition of three-phase has every appearance of reality, and that it will constitute a worthy rival of one-phase methods we do not doubt. At present, however, one-phase apparatus is attracting the greatest attention, and the exploitation of it is a striking feature of electric railway enterprise.

The electric tram is not yet beaten by the motor 'bus, and will make a long fight for first place in public favour. Petrol vehicles will, however, certainly restrict tramway expansion in country districts and small towns which otherwise would have been interlinked with electric tramways. Trams have too good a hold on our great centres and industrial districts to be shaken lightly from them, as will be found in the immediate future by motor 'bus aspirants to popular approval. Over wood pavement and well-kept roads the motor 'bus will answer, but tyre troubles would kill it on rough and cobbled routes.

Communication presents records which are all for telephone development and expansion. The rise of the telephone is something to wonder at, and in this country we do not fully appreciate it. The struggle with monopoly in America is giving the people cheap and efficient communication, while we in this country must labour under costly and inadequate service resulting directly from a needless and unsatisfactory compromise.

The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month ·

❧

Our Fifth Volume.

The present issue contains at the opening of each section a brief review of progress during the past year. We hope readers will find these records both interesting and valuable for reference, as although we have avoided statistics, certain dominating features of advance are chronicled which more truthfully convey what progress has been made. This review matter in the current number displaces the usual articles which generally preface our sections, and it also excludes special data which we shall introduce into future issues. In fact there are a number of important changes which cannot be initiated in a souvenir issue, but these will be put forward in detail next month. In February, therefore, we shall commence publishing what we feel assured will be welcomed by readers—a quantity of specially classified data which will be invaluable for reference and make also good reading. Much of the information constantly filling the columns of the world's electrical press is never seen by the great majority in the profession, and it is to supply what is a decided want that we shall include in review form the best of these data and particulars. We have previously invited readers to give us their views in these matters, and we shall heartily welcome suggestions regarding them at all times.

❧

Electricity and the General Election.

Our great-grandfathers would have been astounded if they could have heard or even read that "a few moments after the announcement of the late Prime Minister's defeat in Manchester, enormous crowds in London were cheering the result." The recent General Election has indicated in a remarkable manner the enterprise of newspaperdom in taking full advantage of modern methods of communication. Not the least remarkable has been the extensive use of the telephone for the announcement of results, and in many cases its complete dominance of the field once exclusively held by the telegraph. The anxious times of waiting in crowded thoroughfares for results and the irksome delays of published figures in the papers are now things of the past, but they have only become so by the zeal and willingness of news organisations. True it is that advances in electric communication have contributed largely to this end, but the incentive, and in many cases the initiative, have been shown in newspaper circles. In the matter of quickly placing the returns from all parts of the country in readable form, the electro-motor has played the most prominent part. But for this handy power agent the public would need to wait many hours longer for its news. Swift-running presses and type-setting machines are only possible by reason of the efficiency, reliability, regularity, and economy of the electro-motor, which is now coupled to each printing or typing unit, making it independent of its fellows, while, in addition, its particular output has been increased. The 1906 Election has been a victory in more than a party sense. It has proved for electrical methods a veritable triumph.

❧

Mr. Patchell's Paper.

So little interest has been taken in the papers read before the London Meetings of the Institution of Electrical Engineers, that Mr. J. H. Patchell's paper will go down to posterity for its outstanding merits over previous contributions to *The Journal.* The paper and discussion are noteworthy from an electricity supply standpoint, and doubtless both will be preserved for reference over an extended period. Mr. Patchell has charge of one of London's most important and active undertakings, and he is always looked up to as an authority on electricity supply. In fact he invariably towers over the professorial element which has made the London meetings so insipid and valueless for so long. It was to be expected that the paper would come in for criticism of the wrong kind, and in refusing to give figures of cost which were really outside the scope of the subject we think Mr. Patchell was well within his rights. The discussion was fruitful of much good matter on the subject of steam raising, and for this alone is worthy of preservation. That engineers have yet to be unanimously in favour of mechanical stoking was evident from the discussion. The nitric acid bogey did not produce the effect one could have expected, but this may be attributed to the paucity of data, and comparative lack of experience of the trouble in the more modern types of alternators. We must not forget to mention that the uses of the oscillograph in practice are fully justified by the results given during the discussion on the nature of circuit oscillation when opening on break switches.

Wireless Telegraph Experiments are being conducted from this Martello Tower, at Norman's Bay, Sussex, with the Johnson System described in the Telegraph Section this Month.

* * *

British One-Phase Traction. In our last issue a writer in the traction section decried the lack of enterprise in British electrical firms in the field of one-phase railway work. Since that was written the contract for the London, Brighton and South Coast Railway suburban electrification has been awarded the Allgemeine Elektricitats-Gesellschaft of Berlin. We must congratulate the company on securing this order in the face of considerable competition, while, further, their action is to be commended in agreeing that the major part of the work shall be done in this country. There was not the least reason for the outcry in the daily press against the decision of the company to draw upon German experience, which is very considerable in this field, for its first electrical suburban section of line. The contract price is stated as being a quarter of a million, but only some £20,000 worth of this work will be undertaken in the Berlin shops of the A. E. G. The Eichberg-Winter repulsion motors will be used, and the completion and operation of the system will be awaited with interest. The future policy of British railway engineers in the electrification of their lines may be greatly influenced by the results obtained with this equipment, as it is the first of the kind to be installed in the country. Experience on home lines and under local conditions will alone substantiate the claims of pioneers in this field.

* * *

C. T. Yerkes. With the passing of Charles Tyson Yerkes the railway world loses a striking personality, a strenuous worker, and a man. Whatever the mistakes of great men some justification for them is generally left to humanity. It is not our desire to deal with Mr. Yerkes' mistakes, because his intentions were good, and all else must stand to the credit of things as he found them. He represented a type of that school of men which does things, and rides rough-shod over obstacles to bring them to pass. Yerkes was a worker from the start, as, indeed, any man must have been who could place behind him eighteen years' labour in consolidating 500 miles of elevated and surface railways in Chicago. This task included, of course, that of electrification from horse cable to steam traction. Again, come nearer home, to London. Just now a stranger visiting the Metropolis can only see a third of what Mr. Yerkes has done to solve its traffic problems; but even that represents much. The Metropolitan and the District are electrified, how, for the moment, does not matter; but the thing is done. Guess you didn't know the old District, eh! stranger? Then, again, below ground are some thirty miles of double tube line to link up greater London, made possible by the financial genius of Mr. Yerkes. He said truly that his legacy to city dwellers and civilized communities generally would only be known when he was beneath the sod. From his considerable fortune, built up by exertion of the most arduous kind, he contributed largely to scientific research, while his incomparable art treasures are bequeathed to the public. He was in his sixty-eighth year at the time of his death.

Photo] [*Elliott and Fry.*

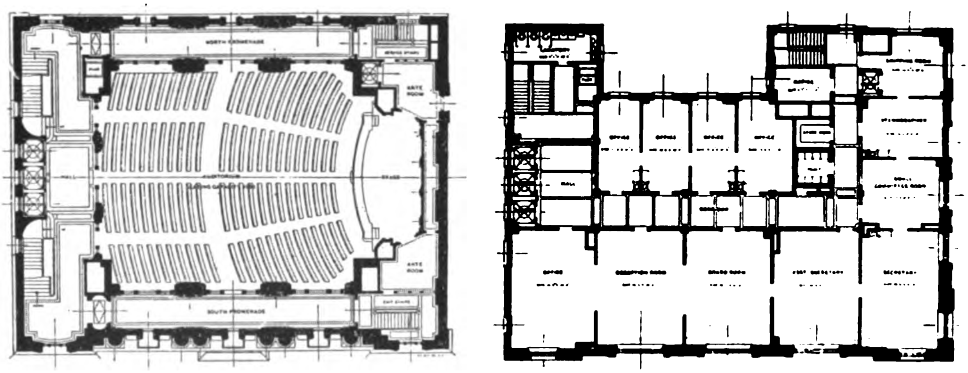
THE LATE MR. C. T. YERKES.

(Block kindly lent by the *Railway Gazette*.)

⁂

George Westinghouse to the Rescue.

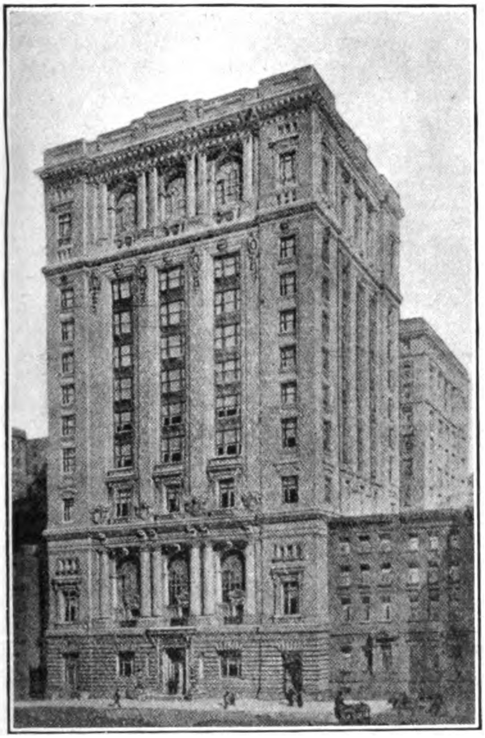
WE have already familiarized our readers with the agitation in New York electrical circles on the subject of one-phase traction as adopted by the New York, New Haven and Hartford road, and direct-current traction as being installed on a mammoth scale on the New York Central. It may be noted that the respective schemes are engineered by the great rival electrical companies, the Westinghouse and General Electric, between whom for twenty years there has been a bitter struggle as respective champions of the alternate and direct current systems. The strenuous fight of the lighting days, in which each sought prominence for its system, now finds a direct parallel in the railway field, and time only can show whether each will drop into its particular place, as happened after the first-mentioned encounter. Mr. George Westinghouse has, however, now descended into the public arena, and the infrequency of his utterances compels a hearing for him when his voice is raised, as is usual with him, in protest against injudicious and thoughtless statements. In the columns of the *Railroad Gazette* he refers thus poignantly to the commercial rivals of his concern. "Public discussion and the facts already demonstrated will bring discomfiture to that organization which has made a long and losing fight to acquire a monopoly of the electric light and power business of the country, and will ensure the acceptance in this country of the single-phase system as the only solution of the electric traction problem on main railroads." Mr. Westinghouse then referred to a striking communication made by him to the President of the New York Central, in October last, in which he drew attention to the limitations of third rail d. c. working, and pointed out that it was not too late for the company to reconsider its decision, and without alteration to its power-house and sub-stations, yet adopt the one-phase system. This letter contains so much strong sentiment and sound data on one-phase railway working that we shall deal more fully with it next month. At the moment we cannot find space for more than the above brief reference to it. It is at least clear that both the great American electric companies realise the issue at stake, and each is doing its utmost to find acceptance for its particular system. At the moment, however, with the guarantees of the Westinghouse Company to the New Haven Railway, and the fact that their system employs an overhead working conductor supplied with current at 6000 volts, the alternate-current method has a long start of direct current, which, if advocating a higher voltage, must be compelled to make costly experiments, while its rivals will meantime be operating on the road. It really looks as if the fight will resolve itself into a tussle between one-phase and polyphase rather than merely a. c. and d. c., as the Ganz Company have a strong competitor to bring into the field in their particular system. The electric railway situation has certainly now entered upon a highly interesting stage.



PLANS OF FIRST FLOOR AND AUDITORIUM OF THE UNITED ENGINEERING BUILDING IN NEW YORK.

A great Society Building.

LONG before the great engineering societies of this country can hope to be identified with a single building which shall adequately represent their interests, the important bodies of the United States will control their business and conduct their proceedings from one central Institution. This idea of concentrating the operations of societies serving, in the main, common objects of national import should be fostered in all great industrial communities, as nothing could better conduce to harmonious relations in quarters where they are most to be desired. It was a happy thought of Mr. Andrew Carnegie, that of placing the great American Societies of Electrical, Mining, and Mechanical Engineers under one roof in New York City, and, further, he made it possible by presenting the building to them. Once conceived, steps were immediately taken to bring the project to fruition, and we understand that the extremely handsome and appropriately ornate building will be completed at the fall of the present year. In addition to providing more complete accommodation for the conduct of the societies' business ample facilities are afforded for their extensive libraries, while a spacious auditorium will serve for the regular meetings. The library will be at the top of the building, and it is expected that the combination of volumes and printed matter will constitute a collection unrivalled anywhere. The co-operation of the New York Public Library will ensure the requisite organization to consolidate the various interests represented. Meantime we must be content to raise our voices in borrowed halls, and enjoy the splendid isolation of Victoria Street.



The Engineering Building as it will appear when completed in New York.

◆

Manufacturers and the Technical Press.

We have received an open letter from the Allis-Chalmers Co. of Milwaukee voicing a plea by its Department of Publicity for suitable co-operation between manufacturers and the representatives of the press. Complaint is made of the difficulty which technical journalists experience in certain quarters in obtaining accurate information when being conducted over works. It is stated also that a particular editor, whose name is not given, could not obtain articles from the experts of manufacturing companies without some difficulty. The company offers to remove these difficulties by doing everything possible to provide adequate facilities for press men, and by furnishing reliable technical data as required. The appeal of the Allis-Chalmers Company points to a slack state of affairs between manufacturer and editor on the other side of which we are somewhat surprised to hear. We have always felt that Americans before any industrial people took full advantage of editorial assistance, courting it at every turn. Perhaps the editors are to blame. At any rate we have seldom encountered any difficulty, when being conducted through manufacturing establishments, in procuring details and to spare. On the other hand, we have had and still have that inherent prejudice of certain manufacturers to voluntary co-operation with the technical press to break down. There is the widest possible scope for makers of electrical plant and apparatus to distribute judiciously among technical journals articles and data regarding their progress and work. Very few, however, take advantage of it, though we have noticed recently that a less conservative attitude is being adopted, and manufacturing experts are leaving their holes to air themselves in the broad beams shed by the leading lights of technical journalism.

THE WINDMILL.—X.

Operated by DON QUIXOTE

Looking Backward.

THE god Janus had a special outfit of two faces, one looking ahead and the other astern. This was a very wise dispensation of Providence, as the ordinary man who tries to cast a backward look while he is pushing forward is very likely to bump unreservedly against something heavy. Which is why I, as a rule, avoid casting retrospective glances at an Old year, or from making good resolutions for the New. In fact, the fellow who is in any sort of a position to look back on events is a man to be envied: the pace is so hot nowadays that the majority of us have all our work cut out if we mean to catch up with events, let alone turn round and look at them.

The year of grace nineteen hundred and five has, however, been a rather peculiar one in that we have come out of it alive. Come to think of it, the endurance of the human race is remarkable. For example, we have had an exhibition. Now it will be recollected that in Bunyan's "Pilgrim's Progress" two Progressives went into Vanity Fair, and only one came out. The gentleman that got "done in"—to bring the literary style up to date—was called Faithful; the man who got through was just an ordinary Christian. Anybody who went to Olympia last year with the faintest appearance of having money to spend will appreciate the point of the parable. Christian and Faithful, by the bye, plugged up their ears with their fingers. This remedy was only partially successful at Olympia: it disposed of the showmen's fairy tales, but there were things that you could *smell*. The ozonizer, for instance! I have heard it said that an International Electrical Exhibition had not been previously held in England for thirteen years. Why is thirteen such an unlucky number?

On New Year's Day, 1905, the Baker Street-Uxbridge section of the Metropolitan was opened in an electrified condition (which was also the state of the population of London when the news came), and from that time onward exciting things have been happening on the Metropolitan and District systems. Little pyrotechnic displays in dark tunnels, when the trains did the Cinderella trick with their slippers, do not count, although they caused certain squeals to emanate from lady passengers. Of more importance were the squeals arising from other causes—the brakes. Ease of travelling would be enhanced if those in authority differentiated between a braking and a breaking action. It is unnecessary, in order to break a journey, to break the passenger.

Another addition to the variety of life was the introduction of the automatic doors. These make existence very gay. There is nothing more refreshing than to see the old ladies skipping off the cars with terrified side-glances at the guillotine. I heard a story—I will not Washingtonise it—of a portly gentleman in a frock coat who was compelled to hurriedly divest himself of the garment to escape being hurled by the coat-tail to a horrible death. He had to stand about in his shirt sleeves on the station platform till the train came round again, when his coat was handed to him, beautifully mangled and pressed, by the attendant, without extra charge.

But the principal feature has been the introduction of the verb "to straphang" into the British vocabulary. Anybody who wants a living picture of our primæval ancestors hanging from a bough has only to wrestle into an 8.30 a.m. Charing Cross-Cannon Street carriage. It is calculated that if the present state of things is not speedily altered, forty per cent. of the population of London will in five years' time have dislocated arms and a complete command of language. I got this from a statistician who supplies the weekly penny papers with facts.

Another remarkable thing in 1905 has been the way in which the prices for London Power have climbed down. Immediate y preceding and during the historic enquiry into the Power Bill—which would have gone through had not time and everybody concerned become exhausted—electricity could be bought by the pennorth. In the absence of a better word, this may be described as phenomenal. But—and I have reserved the most tremendous thing till the last—the London Brighton Sleepy-Crawly Railway are getting a hustle on, they have DECIDED (—on with the dance! Let joy be unconfined) —to try electric traction on their South London lines. In order to be the more thoroughly *à la mode* in modern English enterprise they have placed the first contract in Shermany.

With all the work created by these and other activities during the past year, one would imagine that things were looking rosy for the wage-earners. Unfortunately business —as distinguished from labour—has been bad. And the reason is that people have not yet grasped the elementary fact that to work for no pay is about as bad as not to work at all. Firms in order to "turn the corner" have cut prices so low that they have made "the corner" bigger for themselves and everybody else. Hence as regards reaching profits they have about as much chance as a squirrel has of reaching the top of its rotary cage. My best New Year's wish to these mad competitors is that they will leave off trying to "turn the corner,' and will turn over a new leaf instead.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Electric Power Developments during 1905.

Little short of marvellous have been the strides made during the past year, in the installation of electric power stations water, steam, gas, and oil. The first mentioned can boast of the greatest additions, as the number of waterfalls running idle in all parts of the world is still very great, and further, hydro-power is more readily found and applied than is coal. Again, the plant for water-power stations is now well standardized and can be obtained at comparatively short notice, a consideration which is of importance in schemes of this kind. Unlike other prime movers the water engine is a rotary machine, and designing a generator to couple up to it is merely a matter of speed selection from a uniform and limited range, and not of radical modifications to produce types for widely divergent speeds.

The classification of the power developments of 1905 cannot be effected better than under the headings of the prime movers mentioned above, as this is a true index to the actual state of progress made. Before going into the review matter proper, we may with advantage glance at the existing condition of the chief power engines, as this has a direct bearing on the subject.

PRIME MOVERS.

The Steam Engine still holds undisputed sway among the great prime movers of the world, and has every appearance of maintaining it for some years to come. Its design has, however, undergone radical alterations. Even in the year under review, and for the purpose with which we are chiefly concerned—the driving of dynamos—it is unlikely to survive in the reciprocating form. Very large reciprocating engines up to 6000h.p. are certainly giving good results in practice, but they are voted clumsy and unnecessary, even if their economies are remarkably high. The steam turbine has come to stay, and its installation during the past year, in widely divergent forms, throughout the great civilized centres of the world, is clear proof that the older types cannot long survive in this field. Design and construction have received minute attention. Blades are now made by special machinery, and precautions taken to guard against stripping in case of bearing failure in the horizontal types. Parallel flow, reaction, and impulse forms are now built and applied to dynamo driving with complete satisfaction. On the score of economy there seems to be some reticence on the part of makers, but even if the steam consumption be large it cannot be excessive, otherwise it would not be possible to get low costs from turbo-driven stations. The steam turbine is the best possible development in engine construction which could have transpired. With it the steam-driven plant can easily compete with the largest hydro-electric installation, while it has nothing to fear in the matter of size. Without it there would be a danger of countries abundantly blessed with natural waterfalls gradually capturing the manufacturing business from centres relying only on coal.

The Water Turbine industry is witnessing the introduction of quick-speed wheels operating under high heads and employing regulating needle nozzles. This form admits of a construction resembling that common at one time to steam plants—namely, a central generator between two engines. The great feature of the water wheel construction is the employment of only two bearings, both the impulse wheels being overhung. This is a decided departure, but one which seems to give complete satisfaction. The bearings are specially designed, and in the case of a 3500kw. unit the total weight provided for is 66,500lb. at 225r.p.m. Oil pressure at 2000lb. pressure is turned on, and water-cooling connections are fitted to carry away the maximum of heat should trouble arise. Wheels of this type are much used in California under heads up to 1000ft., and so completely successful have they been that they are going down in India and other countries. Great wheels have been erected at Niagara both of the horizontal and vertical types to develop normally 10,000h.p. per unit, and some exceptionally fine engineering feats have been achieved around the great waterfall. There is a tendency to use the horizontal type of turbine with casing and wheels level with the generator, rather than the vertical type which involves costly wheel pits and footstep bearings. In fact, the latter are peculiar to Niagara in the larger sizes, though smaller units are installed in several Continental stations.

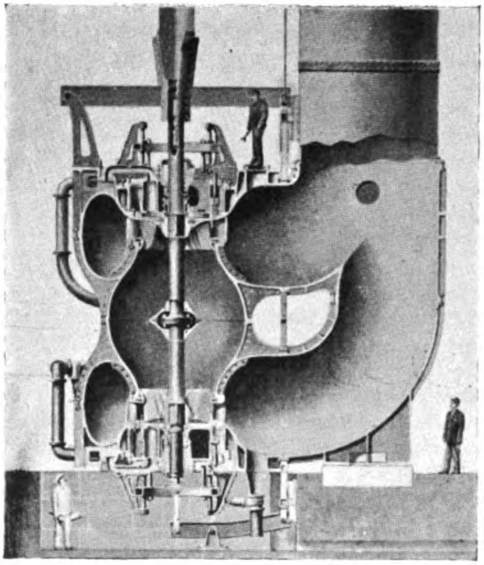
Gas Engines in practice have not done so well in the year as might have been expected. They are still chiefly confined to the horizontal slow-speed pattern, and little or no attempt is being made to depart from these lines. The high-speed vertical engine is not yet out of petticoats and has done nothing to justify its inclusion among the high-powered engines of the day. Makers are feeling their way cautiously with engines of this class, and another year's experience may make considerable difference in the situation. The high-speed vertical engine is to be preferred to the horizontal as a smaller dynamo can be used and the housing of the plant is a less costly affair. Mr. Dugald Clerk has declared the gas turbine to be impossible, but his indictment will not discourage research in so promising a field of prime mover design, unless we have underestimated the powers of modern engineers to surmount obstacles no matter how great. If the birth of the gas turbine is to depend on metallurgical research and achievement we are confident that efforts to obtain this will be redoubled, and if, further, thermodynamics afford no justification for such a machine, means will be found to enlarge our knowledge until such justification is legitimate. Engineering progress has depended on a fearless and unceasing struggle with known and unknown forces, and if present facts yield nothing which will solve problems pressing for solution, no good is done by bemoaning the deficiency. Invention is fostered by encouragement but does not live by it, rather does it become productive when difficulties apparently insurmountable are successfully overcome.

The Oil Engine enters on a new epoch with the vigorous exploitation of the crude oil type. This engine, though costly to construct, is a marvel of economy, and will yet prove the salvation of small stations with a poor day load. Eleven horse-power for a penny will need some beating, and if these figures are obtainable in small sizes, we may look for phenomenal results in the larger engines. Direct coupling is now possible with these engines, and this in itself will bring them to the front, where belt driving would restrict their application.

Hydro-Electric Power.—It would be difficult to name any country in the world which cannot now boast of a hydro-electric power transmission plant. The United States naturally heads the list for number and horse-power of operating plants because its water resources are so vast and opportunities are more than ordinarily favourable for applying them to industrial purposes. Niagara is the most stupendous of American plants, embracing as it does enormous projects for the transmission of its power to the great Canadian cities. When these schemes are in full operation they will extract some 750,000h.p. from the Falls, this figure including the older plants operating now for some years past. The largest station is that of the Ontario Power Company, which will have a total capacity of 200,000h.p., or four times that of the first famous installation Each unit will develop some 12,000h.p. under 175ft. head of water, balanced twin inward flow central discharge turbines being used. The station will be used solely for transmitting power to Toronto nearly 80 miles distant, and steel towers will support the line for the entire distance. Some very large customers are connected up to these stations, and load factors are enjoyed which might be the envy of many steam plants. Cable fires have occurred during the year resulting in shut-downs to certain plants at Niagara, but incidents of this kind are becoming less frequent than formerly.

The Canadian water powers yet undeveloped have been roughly estimated at eleven million horse-power, including the half-million available at Niagara Falls, and of this huge amount the St. Lawrence River alone affords ten millions. Rumours have been afloat during the year of the electrification of the Canadian Pacific Railroad, which has a mileage of 7434, and extends across the entire continent. It is the only large American railway under a single management, and will therefore be able to give unbiased consideration to so great a project. Lakes Erie and Ontario are connected by the Welland Canal, a waterway which is much used for transport. A somewhat singular installation is that which draws water from this canal and takes advantage of a fall of some 268ft. furnished by the altitude of the canal itself. In this manner a water right to draw on the canal at the rate of 700 cubic feet per second for 63 years has been put into operation, and about 20,000h.p. is available at all times. This is now being turned to good account and transmitted at 22,000 volts to Hamilton, about 39 miles distant. Considerable additions have been made to the hydro-electric installations in the East Coast States of America, while in the West transmission over long distance is now a fine art. A notable installation recently brought into operation is that utilizing the glacier waters of Mount Rainer, from the Puyallup River. In Mexico two large plants have come into operation, those of Guanajuato and Necaxa, and further great projects are on foot for obtaining large draughts of power from the great water-bearing areas of the country. American enterprise and engineers naturally predominate in all these localities. In South America developments are also taking place, and already there are several important stations in operation. Proposals for the wholesale operation of the Western Railways from mountain water powers have been put forward, and are not unlikely to be favourably considered.

The Continent of Europe is now alive with hydro-electric stations, especially in Eastern France, Switzerland, Southern Germany, Austria, Norway and Sweden, and Northern Italy. The electrical manufacturing concerns are constantly adding to their already magnificent records in building these installations and lose no opportunity of putting them into operation. An interesting and almost unique plant is that of Zwölfmalgreien in the Austrian Tyrol, in which the water supply to the town is used for an hydro-electric installation. The station is small, only 1500h.p. in three units, but this is sufficient to light the town and furnish a margin for power purposes. The distribution of hydro-electric power in Swiss villages and small towns in the French Alpine departments is causing a revival of home industries which is little short of remarkable. Where tele-dynamic transmission once prevailed electricity is now supplied into the homes of the workpeople, who with a small motor or two manufacture numerous articles of commerce. Visitors to the valleys fed by hydro-electric power are enthusiastic in their praise of this revival. A 36,000 volt installation has during the year been completed for the supply of Venice with some 8000 to 10,000h.p., and according to reports the plant has cost more than any other in Italy on account of the inaccessible position necessitated by local conditions for the power house. The Cellina river, draining a portion



From] [*"Scientific American."*

SECTIONAL VIEW OF 13,000H.P. WATER TURBINE OF ELECTRICAL DEVELOPMENT CO., NIAGARA.

of the Carnic Alps, is drawn upon, and furnishes ample power all the year round. The Italian stations now include among their number an 8000h.p. plant designed and built entirely by Italian engineers. This is at Zogno, and is employed to transmit energy to Ancore, 25 miles distant. The station is now the pride of Italian engineers, and they feel they can now defy foreign competition. The 20,000h.p. station at Vizzola has now been paralleled with a smaller station of 7000h.p. at Turbigo, which was created to cope with the increasing demand. It is noteworthy that Italian capital has now almost replaced foreign financial assistance, not only in the older but also the newer installations for exploiting the water powers of the country.

In Switzerland, Spain, and Norway new stations have been springing up, and the utilization of the many waterfalls seems to keep manufacturers of turbines and dynamos very busy. It is constantly evident from these additional hydro-electric stations that much time and money must be spent on the hydraulic portion of the plant alone. Water, though flowing in great volume, must be collected and directed, and frequently head and tail works of no mean character must be put down long before the site ever sees the machinery. As a rule, little short of three years elapses before a moderate sized station can be got into operation, whereas a steam plant would require but half the time. Again, it has yet to be shown that, in the matter of total costs, the hydro-electric station excels the steam plant with modern boilers and turbo-generators. India, Japan, New Zealand, and South Africa are all to be included in the list of countries operating hydro-electric stations, and of these the first and last present great possibilities—the first particularly, as the glacier-fed slopes of the Himalayas are equalled by few in the world as future centres of hydro-electric power. New Zealand is a land of mountain lakes and swift rivers, and her people have already conceived of the idea of turning these to good account. In a future issue we shall devote special space to the subject, and give exclusive information collected on the spot by one of our commissioners.

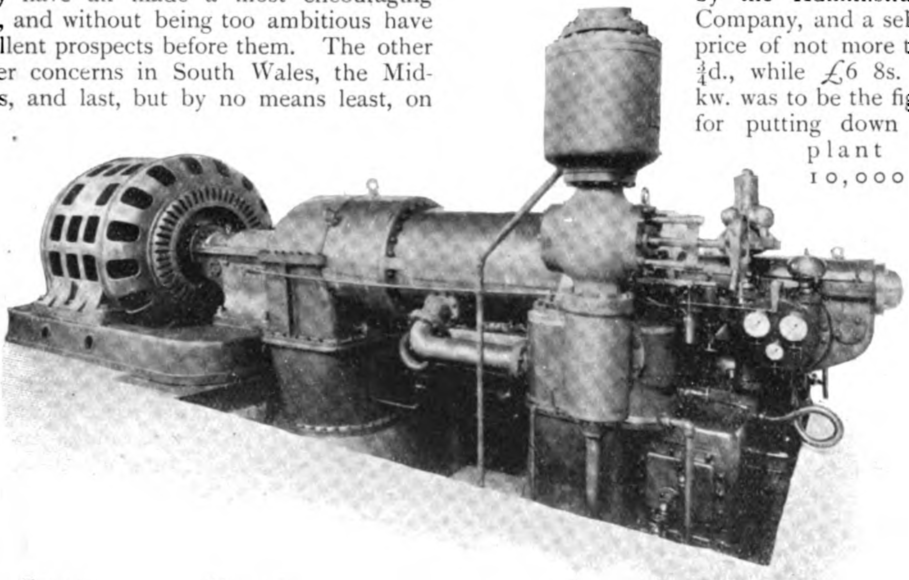
Steam Stations.—From points of size, economy, and efficiency, steam electric power stations have shown a marked advance during 1905. Excepting only blast furnace gas plants the modern steam station is unequalled for low generating costs and high operating efficiency. The power demand for electric railways has pushed up the capacity of power stations, and 100,000kw. plants are now more common than not. America first set the fashion with these mammoth installations, the New York Edison Co. and Elevated Railway stations being among the first to be built The Waterside plant of the former, with an output of 80,000kw. (see p. 376, December issue), reached its maximum output in about five years, and now another monster plant is going down beside it to develop 100,000kw. from vertical shaft turbines. The Boston Edison Co. is gradually filling up a station with an ultimate output of 80,000kw. in 5000kw. sets, and at Chicago a 100,000kw. installation is also being built up in similar sized sets. Either the Westinghouse-Parsons or the Curtis form of turbine is used, the former being horizontal and the latter vertical. The newer electric railroads are relying on turbo-generators for a supply, and the developments in this field around New York, in Philadelphia, Boston, and Chicago, are to be supplied from turbo-operated plant. The New York Central notably is employing the largest standard sets, 5000kw., to furnish the energy for transmission to its sub-stations. Highly superheated steam and good vacuum at the condenser are the standard essentials of turbine operation. A quantity of valuable data culled from experience with turbines is now available, and much assists the operation and maintenance of such plant.

In Europe the Parsons, de Laval, Reidler Stumpf and Zoelly steam turbines are manufactured in various countries with great accuracy and at low cost. Existing steam stations operating reciprocating engines are extending with turbines of some description, and there seems to be no difficulty in finding a good market.

Great Britain has contributed largely to the sum total of turbine progress during the year by the installation of the large units both in railway and supply companies' power houses. The Lots Road station, operating the District and such tube lines of the new groups as are complete, is the largest in the country, or will be when all the plant is installed. The turbines there are peculiar in that the double-flow type is employed, steam entering at the centre and passing both ways to the exhaust. The Metropolitan is also running its trains from similar but small sets in a separate power house. The boiler plant in all these gigantic undertakings would fill a respectable cathedral, if one can make the comparison without offence. Coal handling and storage plant are always accessories and directly contiguous to the steam-raising units, consequently a much larger building is needed.

The new power companies in Lancashire, Yorkshire, and on Clydeside are depending solely on turbo-generated energy and are making a feature of reliability of service. They have all made a most encouraging start, and without being too ambitious have excellent prospects before them. The other power concerns in South Wales, the Midlands, and last, but by no means least, on Tyneside are singularly active and have good business organisations for propagating custom. Smaller undertakings in Scotland have also come into the field, and are the forerunners of others in various parts of the country.

The supply of power to London has become almost a household word during the year, chiefly on account of the vigour and zeal thrown into the attempt to get an important bill—that of the Administrative County of London Co.—through Parliament. The scheme was, as is now well known, beaten on the post by time and had to be dropped until the next session, when it will be revived. Meantime, however, competitors have entered the field, and rival proposals bid fair to eclipse the pioneer attempt to capture London. Of these that of the Additional Electric Power Company is, to our thinking, the most worthy of acceptance. Rumours have gained currency that the whole matter is to be referred to a Royal Commission, but if this transpires, the Metropolis will be deprived of cheap power for another ten years. The outstanding features of these schemes are the low estimates of production cost and the suggested tariffs based upon them; the installation costs are also remarkable—something considerably under ½d. per unit, as given by the Administrative Company, and a selling price of not more than ¾d., while £6 8s. per kw. was to be the figure for putting down the plant in 10,000kw. units. The Additional Company, with coal at 6s. instead of 12s., offers to reduce these figures in spite of its 50 miles overhead transmission line between power house and city. Figures like these are a certain index to the high degree of progress made with steam raising and using appliances, and there is nothing to show at present that even these close results cannot be further reduced.



THE LATEST THING IN TURBO-GENERATORS. A 3,000KW. ALLIS-CHALMERS SET.

A description of the blading will be found in "Manufacturing Progress" this month.

Gas Power Plant.—The gas engine has long been the hope—a somewhat forlorn one—of the electrical engineer dependent on coal for his natural energy, but its development has been so circumscribed that, for his particular purpose, it has availed him but little. Another year has not added much to make the gas-electric power outlook any more promising, and in the matter of installations there is a somewhat barren record. British engineers are as keenly alive to the value of this prime mover as any, and are not contenting themselves by merely looking on. Several have worked their special licences with Continental makers with excellent results, and are prepared to build in the largest sizes. All these machines are of the horizontal type and suitable for blast-furnace gas as well as producer gas. They operate however at comparatively slow speeds, occupying much valuable floor space, and need heavy engine type generators. Several small plants have come into operation during the year at Church Stretton, Heysham Harbour, Limerick, Walthamstow (extensions), and Reading; the latter is a bituminous slack plant of about 2000h.p. High-speed engines are the exception rather than the rule, though those now in operation are giving complete satisfaction. The year has produced its prophets on the gas subject and much attention was given a scheme for piping gas from Derbyshire to London, where it would be converted into electricity through the usual media of engine and dynamo. This may come to pass yet; as an engineering feat it is not impossible at all. The California Gas and Electric Company has given orders for 4000h.p. gas-electric units to operate in San Francisco in parallel with, and as stand-by to, its huge hydro-electric system, and the Warren Jamestown Electric Railway is under equipment with gas engines to operate from natural gas. These indicate confidence in the gas engine and a willingness to go in for large sizes which should be productive of good results. The great improvements in suction gas plants should do much to promote the installation of small stations in districts not served by power companies, and in special classes of isolated plant they are certain to find a field. The gas turbine is what is wanted, however, and we believe that engineers will not stop short of it. We have already referred to the oil engine, and in this regard may mention the remarkable strides made with the Diesel type, which now is guaranteed to give 1 b.h.p. at a cost of one penny for fuel, and can be coupled directly to dynamos at that. We may yet witness oil piped from the oil fields (as it is now done for storage purposes) to industrial centres for conversion on the spot and for local distribution as electrical energy.

MOTIVE POWER APPLICATIONS.

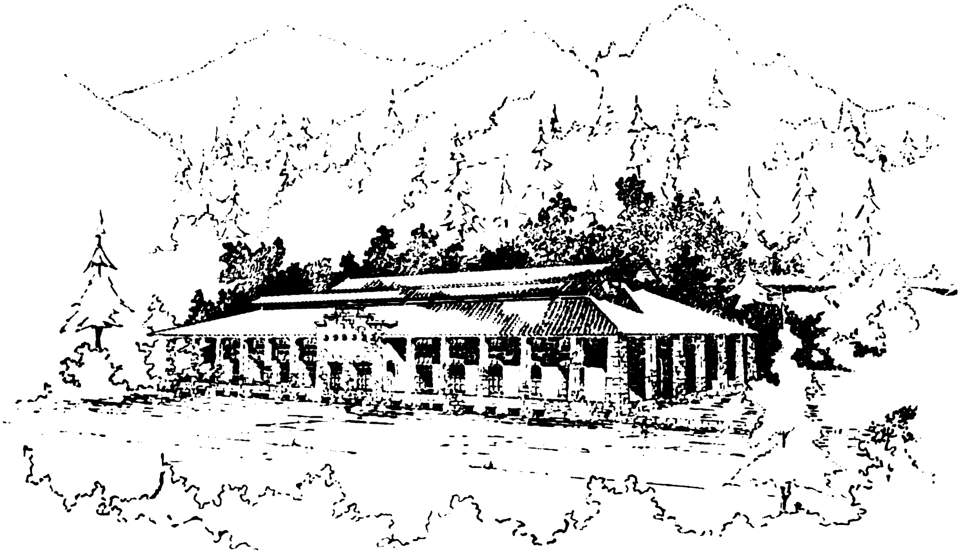
It would be quite beyond the scope of this short review to include all the many applications of electrical energy in everyday life, they have become so multifarious. We must content ourselves, therefore, with brief notices of the principal examples. British textile industries are likely to undergo a change now that electric power is available in Lancashire and Yorkshire, and already the work of ousting steam engines has begun. Simple induction motors replace the clumsy rope drive, and, where group driving is favoured, this is installed. Independent operation is more common on the Continent, and doubtless will soon find favour here. Chimneyless mills will pass from nine-day wonders to the realms of the commonplace, and we may have an "atmosphereless" Lancashire yet. In South Wales a large load in colliery customers is being supplied, and some of the best electrical plant is finding its way into the pits within the supply area. One big ring of pits is, however, being supplied from a separate station. Harland and Wolff's Shipbuilding Works in Belfast are at present supplying themselves with 3000h.p. in motors and lighting, and when the electrical equipment is complete another 1000h.p. will have been added. The electric winding engine is now no longer something for the colliery manager to shun, but a practical piece of mechanism which will do better than his steam plant. Several large types are being installed in the South Wales area.

Engineering shops of whatever kind are now seldom without the electric drive, and there is a steadily increasing demand for the individual motor drive. In America particularly manufacturers are adopting this plan, and apparently with complete success. It is much simplified by the introduction of variable-speed motors with a wide range, which dispense with the necessity of multiple voltage wiring, and boosting or balancing generators All large tools, such as planers, boring mills, radial drills, and lathes, now have their own motors, and in each case the tendency is to reduce the complications of gearing as well as of motor control. Induction motors are much favoured for certain industries, particularly those presenting dangers from loose or moving contacts, etc. In New York is a glucose factory employing 160 odd induction motors aggregating 5000h.p. for operating its plant, and these range in output from 10 to 75h.p. In paper mills the special machinery used is found to operate most efficiently under the individual drive of electro-motors rather than by separate engines or from shafting, and advantage is being taken of this in modern installations. Several American installations break up the trees into wood pulp and carry through the other subsequent operations by electric power.

In the newspaper world electric motors are now grafted in and are part and parcel of the organisation. They could not be dispensed with, and only by their agency is the modern daily paper got out to time. In building operations, motors play an important part, and would do more so if central stations would keep in touch with architects and get a temporary cable in to run hoists and mortar mills. The electric elevator is a triumph of electrical skill, as high-speed passenger lifts are now marketed with push-button control. This furnishes complete safeguard to those using the lift, while it also automatically debars others from using it while in operation.

For portability the electro-motor is unrivalled, and it is not surprising that a highly efficient line of portable electric tools is on the market. For building operations of all kinds, whether of ships or railway trucks, they can be found of immense service, and some of the smallest are operated from a lampholder socket.

Ventilating has received a new lease of life at the hands of electric power, and both industrially and domestically it is unrivalled. The great blowing outfits for ventilating works and the table fan represent the two limits of this branch, and between them are modifications innumerable. In conclusion, the application of electric power to agriculture may be alluded to. Hydro-electric plants on the Continent have created a demand in this direction because of their power lines passing through cultivated districts. Already portable implements and appliances are to be found in operation by rings of farmers, whose yield is increased and work accomplished more quickly than by hand or horse labour. Research in the domain of electricity applied directly for fertilising purposes has yielded little of importance, but there are indications that good results may yet accrue.



THE JHELUM RIVER HYDRO-ELECTRIC PLANT IN INDIA, AS IT WILL APPEAR WHEN COMPLETED.

Jhelum River Hydro-Electric Installation in British India.

THE Government of British India has for some time pursued a broad-minded policy in developing the latent possibilities of the immense and valuable country over which it exercises sovereignty, and its officials have interested themselves in providing for the future welfare and enlightenment of the native inhabitants. Among other laudable projects which the Government has instituted has been the commissioning of some of the most capable Royal Engineers to plan for and construct public works, such as would aid in the general advancement of the native industries and the development of the commerce of the country.

The power scheme next to be undertaken after the Cauvery Falls is the installation on the Jhelum River in Kashmir, in north-west India. This power plant is to be installed near Rampur, about 50 miles below Srinager, where a 6-mile conduit will give a head of water at the plant of about 400ft. The present plans call for an installation of about 20,000h.p.

It is planned to use the power for operating the Kashmir section of the Jhelum Valley Railway electrically along its entire length of 180 miles. A single-phase system of traction will undoubtedly be installed. Possibly the most important immediate use to which the power will be put will be in operating dredgers for the purpose of deepening the Jhelum River in the Kashmir Valley, and thus minimising the floods, which, under existing circumstances, periodically devastate the entire country. The contemplated plant will also allow of the reclamation of a very large tract of land, and permit of the storage of water in Wular Lake above the power plant for sale to the Punjab Irrigation Department. Another important use of the power will be for operating the large silk factory at Srinager, and also for supplying with current the electrical water heaters in the silk mill. In addition, the power will be utilised for other industrial purposes, and for lighting in Srinager and in Abbottabad, Murree, and Rawalpindi, prosperous towns in the British Province of Hazara, lying to the west of Kashmir. The contract for the hydraulic equipment was awarded to the Abner Doble Company, of San Francisco, U.S.A., and calls for the hydraulic plant complete from the forebay to the tailrace, including the intake, valves, pressure pipes, pressure-pipe thrust blocks, interior piping, water wheels and nozzles, hydraulic governors, and all details necessary for the hydraulic equipment.

The gravity conduit line for the power plant will be approximately 34,000ft. in length, and for the upper 8500ft. will consist of an excavated ditch lined with masonry. The remaining portion of the water channel will consist of a rectangular flume, or a wooden stave pipe such as has been installed so successfully in connection with plants of this character on the Pacific Coast.

Twelve main units and three exciter units have been planned for the equipment of the power house. Each main unit will consist of a Doble tangential water wheel with automatic oil pressure governor delivering 1765B.H.P. to the shaft, under an effective head of 400ft. Each wheel will be direct connected to a 1000kw. alternator, the speed of the unit being 500r.p.m.

The water wheels will be equipped with ellipsoidal buckets, needle regulating nozzles and centrifugal water guards. The regulation of the main units will be effected by means of hydraulic governors operating jet deflectors. For the exciter units hand regulation will be provided by means of the needle nozzles. The gate valves for each wheel will be of special construction with outside screw and yoke, bronze-mounted, with by-pass. The power house will be of solid masonry construction and will have a wide veranda as a protection from the tropical sun. A double steel roof will be provided and two travelling cranes will be installed for handling the machinery. The transformers will be installed in a bay of the main building or in a separate structure.

The conditions under which the plant will be installed are decidedly out of the ordinary as compared with similar work in this country. The specifications for the electrical and hydraulic equipment stipulated that no single piece of machinery should weigh more than four tons when packed, for the reason that there are 200 miles of road transportation, including a lift over a range of mountains 8000ft. high. Transportation in that section of the country is limited to bullock cart, and no single piece of machinery heavier than four tons can be transported, a total of five tons including the trolley (cart) being the maximum weight that can be hauled over the mountains. Portland cement costs $7.50 per barrel delivered at the site, making its use prohibitive for heavy concrete work. However, there is plenty of natural rock in the vicinity, so masonry construction will be used for the walls of the power house and for the foundations of machines, intake, forebay, etc.

The entire hydro-electric installation will be constructed, erected, tested and placed in operation under the supervision of Major A. J. de Lotbiniere, R.E. Major D. Fraser, R.E., and Capt. Thomson, R.E., will act as his engineering representatives in London.

TRACTION & Transport

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

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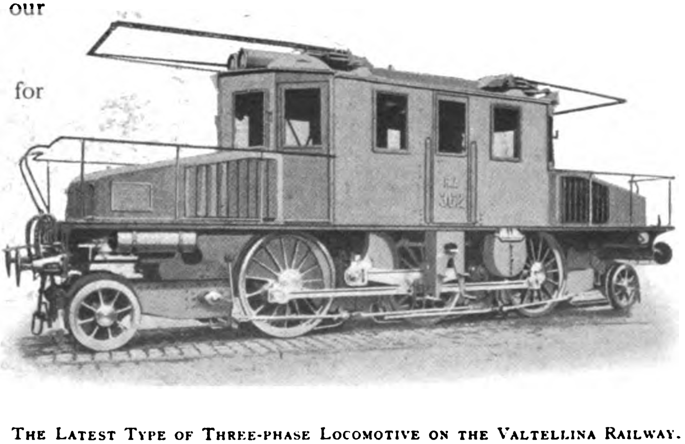
Electric Traction Progress in 1905.

THE work now being carried on in the field of electric traction exceeds in importance that of any other branch of the industry. It is not saying too much that the future of some manufacturing concerns is bound up in the electrification of main line railways; indeed, in some quarters it is an open secret. What the immediate future holds for such, time will show, though if the past year's record be taken as an index, the prospects of big business are certainly of the best. This section of electric traction work must accordingly rank first in our review of the year, as its chief phases will no doubt be of primary interest to our readers.

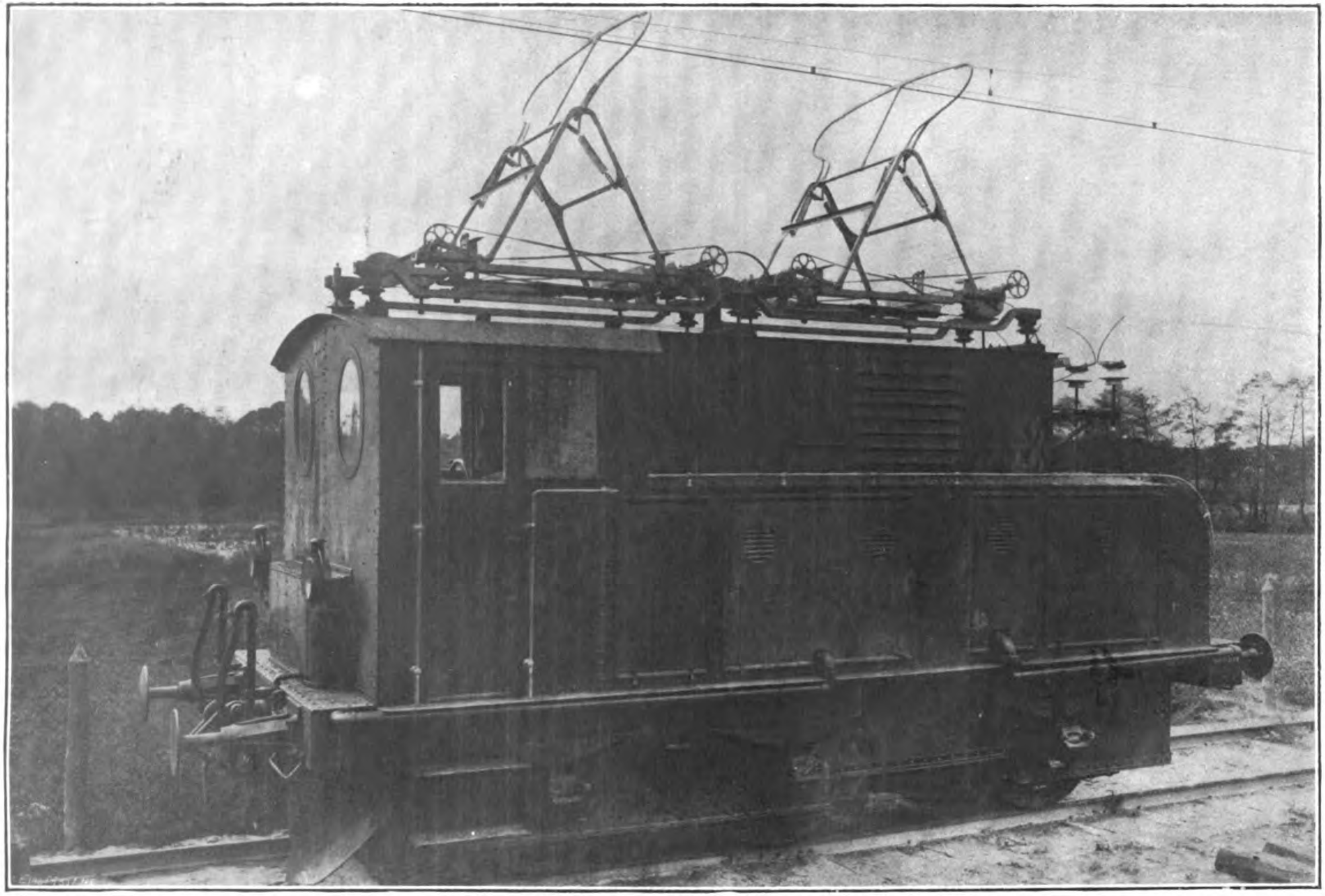
Main Line Traction.

The two great rivals for first place in main line work are the one-phase and the polyphase systems. During the year both have made very rapid strides, but more particularly the former. Two overhead wires were regarded at the outset as distasteful and unmechanical to railway engineers, and one-phase methods have accordingly been developed in every possible way. Third rails also were regarded as unlikely to find favour, and a complete plump for overhead wires with consequent high voltages characterizes a great advance. American and Continental electric railway engineers have hustled each other in the race to equip lines, and from figures at our disposal each have about 110 miles to their credit of lines in operation. The Continental lines are at Spindlersfeld Murnau-Oberammergau, Stubai Valley, du Borinage-Vicinaux, Rome-Civita (constructing), Seebach-Zurich, Vienna-Baden (constructing), and Hamburg Elevated (constructing). Others are under consideration, and final decisions will shortly be announced. The Swedish Government experiments are of great value and should add considerably to standard knowledge on the subject. Of European systems, that which finds most favour is the Eichberg-Winter, and this is in operation or on order for some half-dozen lines.

In the matter of frequency, there has been

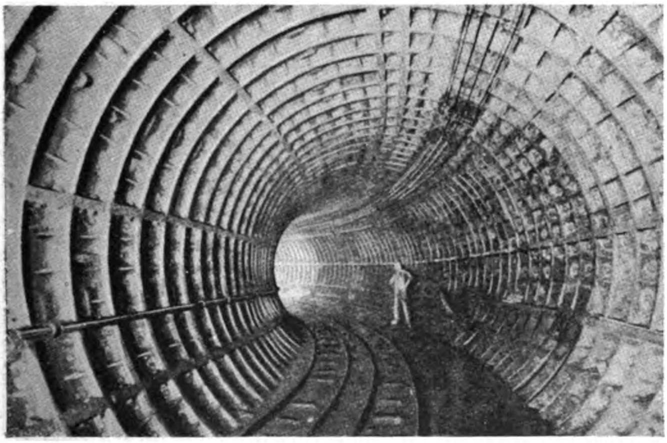


The Latest Type of Three-phase Locomotive on the Valtellina Railway.



The first 20,000 volt Electric Locomotive (Siemens-Schuckert) being experimented with by the Swedish Government.

nothing standard even with this latter system as the lines in operation vary in this respect between 25 and 42 cycles. The trolley voltage is more uniform at 6000 volts, though in one instance this is dropped to 2700 volts. The Siemens-Schuckert system is next favourite; it is operating in Bavaria and Sweden, while it is to be adopted on the Vienna-Baden line. The highest trolley voltage experimented with is 18,000 volts, by the Swedish Government. In America a number of short lines are operating with the Westinghouse and General Electric Systems and are giving excellent service according to latest reports. Both are equally suited for direct-current operation, and the existence of so many lines supplied with the latter almost necessitates the offer of the combined system when tendering. American one-phase traction in the year under review is marked by distinct improvements in apparatus and a willingness to construct the largest types of locomotives. This is evidenced by the contract recently awarded the Westinghouse interests for twenty-six locomotives for the New York, New Haven, and Hartford Road, these locomotives to be fitted with gearless motors and to operate on either direct or alternate currents. Contracts for long stretches of line have also been entered into, and there seems to be no lack of energy to boom one-phase methods for what they are worth. Whether railway companies will respond to this enthusiasm remains to be seen, but certain it is that most steam road interests are now keenly alive to the necessity for electrification on some system of their suburban tracks. One-phase traction in the United Kingdom is to make its first appearance on the London, Brighton and South Coast line, and its adoption, though experimental, will certainly be fruitful of result. Judging by developments in this field, railway engineers are in favour of the overhead line and consequently of the one-phase system.

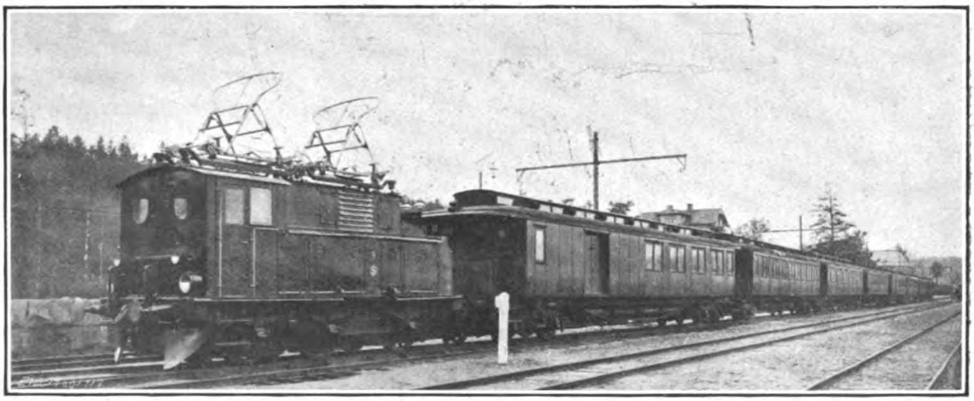

From the] [*"Scientific American."*

A TYPICAL CURVE IN THE TUNNELS INTO NEW YORK, UNDER THE HUDSON RIVER.

Electric Trains only will ply in these tunnels.

Polyphase traction advocates have been singularly active during the year. The Valtellina line, which is the starting point of heavy traction of this kind, has been improved, and a new type of locomotive put on which, both electrically and mechanically, is remarkably efficient. Figures comparing the various systems are closely followed by the Ganz Company, and the best possible case has been made out for polyphase methods. The British interests of the company are in the hands of Bruce, Peebles and Co., Ltd., and the American in those of the Railway Electric Power Company. In this respect it may be noted that the former concern has entirely built the motors and equipment of the London-Ontario line, which is the first three-phase direct-current installation being put down in America. This combination emphasises more than ever the need, in the United States and Canada, at any rate, of putting forward duplex motors when seeking orders for high voltage railway material. The Brown Boveri Company is also coming to the front again with polyphase traction, its experience at Bergdorff-Thun, and the Jungfrau being of exceptional value in fitting it to undertake heavy duty equipments. At the outset it has secured the contract for a polyphase service of trains through the Simplon tunnel. This will, of course, be a special piece of work, but it will represent difficulties with the two overhead wires which should add considerably to current knowledge regarding their reliability. The revival of polyphase traction, for such it may be termed, can have no other justification than the rapid development of the one-phase system. Otherwise the period of inactivity between the completion of the Valtellina line and the present time goes unexplained. The one-phasers have brooked no denial in urging their claims, and by sheer weight of numbers have forced themselves to the front. With several years of patient indolence, devoted perhaps to tests of systems built, polyphase traction engineers have lost valuable opportunities and now have a lot of leeway to make up.

The direct-current system can boast of continued extension for short stretches of line, and adoption on a number of important inter-urban roads in all parts of the world, but the limits to operating voltage and objections to third rails are becoming prejudicial to the system. The New York Central has adopted it over its suburban tracks and is in process of converting these at the present time, but so great has been the advance with one-phase methods that the company has been urged to reconsider its decision. The situation has been precipitated by the decision of a neighbouring company, the New York, New Haven and Hartford, to employ one-phase traction on its routes, and a most complex state of affairs seems to prevail. The expenditure of so much money on direct-current working by the New York Central is viewed with some concern, and in the interest of electric railways generally Mr. George Westinghouse wrote last October to the President of the road pointing out the obvious need for a change to alternate current. We comment on this in our editorial columns. The arguments in favour of alternate currents for railways seem to be so strong that it does not appear feasible that direct-current devotees can reasonably request the production of high-voltage equipments of their system, thereby involving delays and uncertainties for another twelve months or more.



20,000 VOLT SWEDISH GOVERNMENT LOCOMOTIVE HAULING A TRAIN OF EIGHT CARS.

Electric Tramways.

According to the enlightened, electric tramways must suffer death at the hands of the motor 'bus, if one can so describe it. The past year has produced nothing to show that such will be the case either immediately or subsequently. Increased production and employment of motor omnibuses has certainly emphasised their limitations and more sharply defined the field in which both they and electric tramways shall operate. While in no way minimising the many good features of a trackless vehicle, there is not sufficient evidence at present to justify any but the most guarded statements, comparing petrol vehicles and tramways. It cannot be denied that increased experience with heavy petrol-driven vehicles will bring out their capabilities and perhaps permit of direct competition with trams, by petrol cars running on rails. There is greater danger to electric tramways from this source than from any other, and it should not be lightly set aside as having no bearing on the question. There is no denying that tramway development in small towns has not shown any marked advance in this country, at any rate during the year. A number of towns have completed and put into operation tramways of varying extent, and cities like Belfast and Birmingham are also noticeable in this respect. But these schemes were all promulgated before the omnibus boom, and it is to be expected that during the coming year a greater falling off will be witnessed in the demand for electric tramway material.

Regenerative control, which is now placed indisputably beyond the pale of experiment, will do great things to keep up the electric tram in its competition with petrol. Whole systems have been equipped with it during the year and are finding its claims to be in no way exaggerated. The Birmingham and District Tramways form a noteworthy example, and in this instance the operating costs are further enhanced by the use of Diesel engines at the power house. The improved types of this engine are likely to revolutionize small power house design, and already the company is actively exploiting them in connection with tramways having limited mileage. This introduces another saving clause into the argument for the electric tram and presents a combination of oil dynamos and regenerative control which will easily compete, on running costs, with the motor 'bus. Stations and tramway systems driven by steam should also be able to take advantage of this combination.

Abroad this kind of competition is not likely to make much headway, as roads are not so good and the distances to be covered are greater. Bad roads are, however, the chief factor, and while motor 'buses may beat electric trams in certain fields in this country there are few indications of their meeting the same encouragement elsewhere.

Among improvements introduced for tramways may be mentioned grooved trolley wire, point shifters, radial trucks and steel tyres. The Tramway and Light Railway Exhibition did much to give prominence to the advances made, though there was a significant falling off in the support given to the Exhibition compared with that previously accorded. The furtherance of tramway interests among tramway men prevails and the many societies and associations contribute valuable and frequently unique data for the use of their confrères.

Canal Haulage.

The subject of electric haulage for canals, and particularly British canals, has received much attention during the year, and is likely to be fruitful of result in time. In this country there are nearly 4500 miles of canals, of which some 28 per cent. have become derelict. It is a burning question how to make these profitable media of transport, whether in the hands of their present owners or the Government. Competition by the latter with railway goods traffic, even if electric canal haulage prevailed, does not present an encouraging outlook for the canals. Electrification certainly increases the earning capacity of inland waterways, as has been proved on the Welland and Soulanges canals in Canada and America, but, in the case of this country, the initial expense of purchase, if undertaken, and equipment, and subsequent competition by railway interest, would kill the enterprise at its birth. We can only await political and electrical developments which will enable us to launch out hopefully into this field of transport.

Automobiles.

Electric automobiles are about where they were when last we reviewed the industry. Their exploitation is limited, not by electrical but by electro-chemical difficulties, and, until these are surmounted, the present extent of sixty miles for a small two-seater will represent the distance to be covered. In London and other large cities, but in London particularly, a remunerative business is done in the hire of such vehicles, and they continue popular in spite of petrol competition, because they are always silent, elegant, comfortable, and swift. Nothing can take from them these—their exclusive charms.

Petrol locomotion still depends on electric ignition, either accumulator or magneto, and the latter especially is now becoming first favourite both for cars and cycles.

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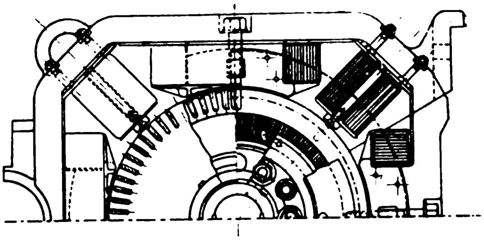
High Voltage D. C. Traction.

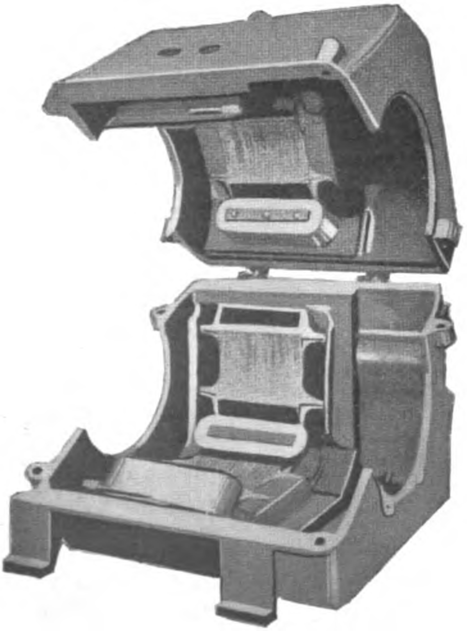
THERE are strong indications of the development of the electric railway situation into a keen fight for predominance between high voltage alternate currents and moderate voltage direct currents. Already there are in operation on the Continent short lines of railway operating with d.c. motors at 1,000 volts, and certain manufacturers are

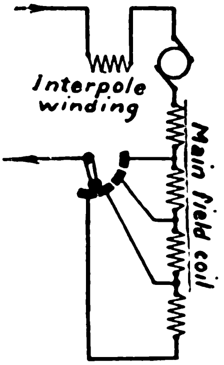


Field System and Armature Section of 800 volt d.c. motor.

willing to construct such machines for pressures up to 1,500 volts. A 700 mile transmission line has been proposed for the Victoria Falls power scheme, and a marked opinion favourable to direct currents is now becoming evident in many quarters. Mr. F. G. Sprague announces in the *Street Railway Journal* that he is prepared to build any length of line and equip it with 1,500 volt d.c. apparatus, while he strongly contends that this is by no means the limiting figure for such equipment. He thinks that railway engineers when considering electrification should have the choice of both a. c. and d. c. apparatus, and for this reason he is prepared to push forward the present limits of d. c. operation. Incidentally he stated that doubling the working voltage would, on an average, treble the sub-station distances, and trebling the potential would increase this distance five times its present limits. Our esteemed contemporary, in remarking upon Mr. Sprague's announcement, says: "The advent of a 1,000-volt d. c. system of traction would be a good thing in and of itself, quite apart from its effect on a. c. railway work. So far as we can see, the art will be greatly advanced whatever the outcome. If the a. c. motor is able to push its d. c. confrère upstairs into the region of economical voltage, so much the better for the railway business at large. What the practical railway man wants is a cheaper and more efficient system of equipping long lines than now exists. The particular kind of apparatus by which the result is achieved is a matter of comparative indifference, for he will have to make considerable changes in his equipment in any event. Therefore, he looks at the present discussion cheerfully and without fear of the final result." From all the facts of the case at present available, this is undoubtedly the most logical view to take of the situation.

In this connection, we may refer to the new 200-h.p. d. c. motor of the Oerlikon Co designed to operate on 800-volt traction circuits. We also give illustrations of the machine, taken from *Electrotechnische Zeitschrift.* The normal speed is 400 revolutions, at which the maximum h.p. is developed, but 1000 revolutions can be attained without danger. There are 518 armature bars, 2 per slot, and the commutator has half this number of segments—219. The bars are placed in holes and not slots, and the field is fitted with interpoles to improve the commutation. Speed regulation is obtained by cutting out one or more of the field windings as shown in the diagram. It is stated that this in no way interferes with the commutation. Further developments of this motor will be awaited with interest, though it must be admitted that there still exists a big gap between the operating voltages of a. c. and d. c. apparatus. A 20,000 volt. d. c. locomotive seems at present to be very much in the future.





200H.P. 800 volt D.C. Traction Motor with Interpoles. Connections shown on right.

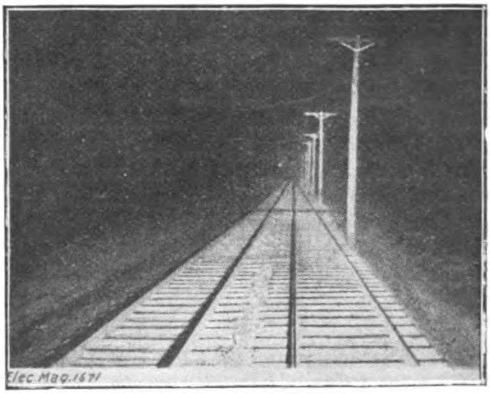
LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Progress in the Electric Lighting and Heating Arts.

In former years the reviewer of progress in electric lighting and heating found the field so barren of result that he generally dismissed the subject in a few lines. The record of the past year is, in contradistinction to its predecessors, both one of marked progress and widely applied results. Research has hitherto been so meagrely rewarded that prevalence was given to the idea that further improvement of existing pattern lamps was impossible of accomplishment, and prophets foretold the decay of electric lighting under the fierce competitive fire of gas. Experience however enables us to give the lie to these ill-timed utterances and to record a year's work which marks an epoch in the history of the art.

The incandescent lamp deserves first attention, as it has the greatest vogue. Much to the surprise of everyone, the old carbon filament lamp, which was to have but a short career against the newer metal filament lamps, has been given a new lease of life by a process which heightens its efficiency and prolongs its burning period. The ordinary filament after treatment in the usual way is subjected to the great temperatures of the electric furnace and its outer surface assumes a metallic structure which remains permanently when the filament is cooled. Lamps with an efficiency of 1.75 to 2.5 watts per candle are obtained by the process and users are already beginning to corroborate the figures announced by the makers before putting the lamps on the market. As far as we are aware the process is not patentable, and although it is being employed in an American lamp factory, experimental work of a similar kind is claimed by some makers in this country. From this it would appear to be another instance of American capacity for nursing and expanding ideas conceived but only experimented with over here. The new year should witness a move on the part of other lampmakers to put this process into operation. Efforts of another kind to improve the carbon filament lamp which come from America and have been widely copied here have met with considerable success; we refer to the over-run filament lamps with large bulb and reflector. Lamps of this type were introduced late in 1904, but the past year has witnessed an enormous increase in the number used, and in this particular considerable humour attaches

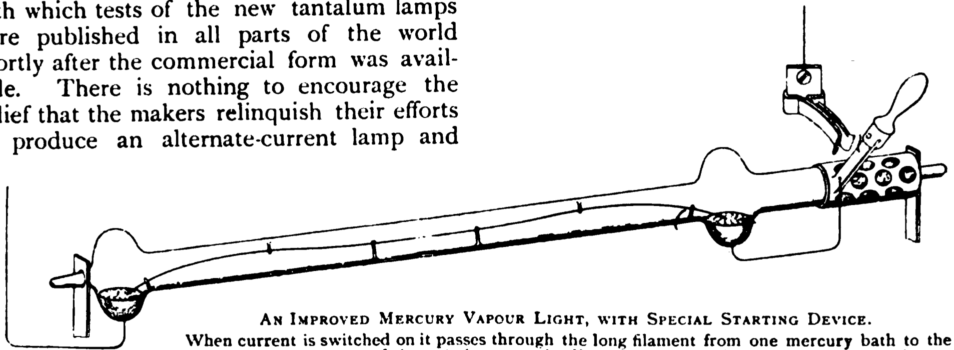


American Railway Tracks as Lighted by Electric Head-light on Locomotive.

Drivers can see over a mile ahead. Current for the searchlight is turbo-generated on the locomotive.

to the efforts of the makers in the christening of their respective lamps.

Of the new metal filament lamps little can at present be said. It was announced at the Olympia Exhibition that the new tantalum lamps were best employed on direct-current circuits, and another limiting feature of the lamp is its restriction to pressures below 120 volts. For the regular 200 volt service adapter holders are required, but these are perhaps almost naturally not included in the price of the lamps. This latter at present stands at a very high figure—5s.—but this is largely discounted by the fact that the lamps consume but half the energy of the ordinary type. The great extent to which electrical testing laboratories are employed is clearly testified to by the alacrity and consistency with which tests of the new tantalum lamps were published in all parts of the world shortly after the commercial form was available. There is nothing to encourage the belief that the makers relinquish their efforts to produce an alternate-current lamp and push upward the limits of pressure which now confine the lamp to the lower and less common voltages in use. The osmium lamp, which like its fellow metal filament lamp hails from Germany—where the mantles come from—has been more vigorously exploited during the year, and after the Exhibition a fall in price was announced from 7s. 6d. to 5s. per lamp. This lamp is narrowed down even more than the tantalum in its sphere of application. The highest voltage is in the neighbourhood of 65 and the lamps must be hung vertically downward to burn satisfactorily. The efficiency again is high—1.5 watts per candle—but initial cost and adapter holders are likely to restrict the very wide uses of the lamp. These developments, hampered as they are by what appear fruitless compromises, are encouraging signs of progress. They indicate a genuine desire to improve the incandescent lamp, and further, they are steps in the right direction. A metal filament has all the elements of strength and durability, and when the ductility of most metals is considered, the process of manufacturing filaments cannot but be simplified. The metal filament lamp is an undoubted triumph for the electro-metallurgist.



AN IMPROVED MERCURY VAPOUR LIGHT, WITH SPECIAL STARTING DEVICE.
When current is switched on it passes through the long filament from one mercury bath to the other. Movement of the switch rotates the filament ends out of the baths, and when the arc is started the filament is completely cut out of circuit.

Experiments with rare earths for incandescent lamps burning in the air still continue, but meantime the Nernst form of these lamps appears to flourish. The flat pattern of heater seems to give every satisfaction and the downward distribution of light from it is undoubtedly advantageous. The makers of the lamps have lost no opportunity in pushing its claims and, judging by results, they are remarkably successful. The multiple glower pattern of lamp is also giving good results, and forms a strong rival to small arcs for shop window and interior lighting. Despite the trouble in renewing burners the lamp is becoming popular, doubtless on account of its soft, white light. We should very much like to see the lamps used on trains, but doubtless this will come in time. The railway companies are making experiments with inverted gas mantles, and if these can be put on a passenger-coach so also can a Nernst lamp. Lamps of this type have their special field of application, and their most enthusiastic devotees find this out in practice. The makers, however, are alive to the fact that several patterns of lamp must be offered to meet the requirements of widely divergent needs of illumination.

The mercury vapour lamp is still in a more or less embryonic condition, and the original difficulties with starting and the quality of light emitted are more than ever apparent. Types are marketed which can be started from a distance, but it is questionable whether the means employed are likely to find favour. For side street lighting and special photographic work the lamp may become popular, but at present a great deal remains to be done to encourage extended confidence in it.

The most notable advance of the past year is to be recorded in the arc lighting world. Both for interior and exterior lighting the arc lamp has been very greatly improved. Single enclosed arcs are now common, and a twin carbon lamp has been developed which allows of single burning of lamps across 200 volts. The feed mechanism has also been much simplified, and lamps are now obtainable without shunt coils. In one pattern a hot wire is employed as the controlling element with complete success, so that coils of every description are dispensed with.

The improved flame type arc, however, is the most notable feature of the year's work in this field, the chief advances being in the simplification of the control and the manufacture of the carbons. The carbons in every case are placed *above* the arc, which burns under a reflector and is magnetically controlled. This at once improves the downward distribution of light and removes all shadows. In its present state the lamp burns about 50 hours, but efforts are being made to enclose the arc and thereby extend its burning with one set of carbons. A most encouraging response from the public in the use of these lamps has been noticeable during the year, and they are now quite common objects outside shop windows.

In the domain of street lighting much encouraging progress has been made. Nernst lamps are now becoming common in small towns and the side streets of cities, and the engineers responsible for their installation and maintenance are not afraid of publishing reliable figures regarding their operation. This is more than can be said of the gas interest, which talks wildly and vaguely of the superiority of its mantles, but gives nothing to support its claims. Such satisfactory progress is to be recorded in street lighting by electric lamps, both arc and incandescent, that it is safe to predict the complete failure of gas in any form in competition with them. Such nefarious proceedings as the capture of the City of London street lighting by the gas companies are beneath the notice of self-respecting engineers and can only be productive of one result. Mendacity in business may be fashionable, but it is "side-tracked" from the start, and ultimately "gets left." On the highest authority it is stated that modern flame arcs are more economical and give both a better and more intense light than the best high-pressure gas lighting known. Considering the position of the flame arc lamp at the moment, this means that in another twelve months electrical engineers will be in a position to claim undisputed control of street lighting, whether for main or by-streets. Gas is fighting a forlorn hope, and to the credit of its exponents it may be said that they know it, and by their actions partially admit it.

Electric heating has certainly not boomed during the year, but it is the next thing electrical which certainly will. Although no phenomenal progress in the design of electric radiators can be shown, makers of the present standard types have been, and are still, working full time, and in many instances are booked ahead with orders over several months. The radiant heat pattern radiator commands a ready sale and is being produced in very large quantities. Similarly, cooking apparatus is experiencing improved sales, and the special inducements of hire held out by some supply concerns is exciting public interest in the apparatus. From their extended use devices for this purpose are proving remarkably reliable, while the efficiency has been greatly increased by improved methods of manufacture. The reduction in price of energy for heating, cooking, and power purposes in London by the great companies and borough councils will create an enormous demand for radiators and cooking utensils, as at 1d. per unit these devices are placed on a level at least with the common gas articles now in use. On the score of convenience of course the electric is streets ahead of its rival, while its useful heat efficiency is unapproachable by gas. The business operations of gas companies, especially in London, are a sure index of the growth of electricity-consuming devices. A vigorous campaign has been started against the electric radiator, and grossly exaggerated, not to say libellous, statements are being hurled indiscriminately abroad, that gas is seven times as cheap as electricity. The why and wherefore of this piece of finesse are not forthcoming, and the public is asked to swallow undigested facts. Although on the score of heat units *produced* the gas fire excels the electric radiator, in the matter of heat units *applied* it is not anything like so efficient. The gas companies carefully conceal this interesting piece of evidence, but it does not need figures of any kind to substantiate it. The gas fire is anchored to the chimney-tail, and though energetic enough in making heat, is perforce compelled to hand over its warmth to the draught pipe. What proportion finds its way into the room users of gas fires know. The electric radiator has no such embargo placed upon its efforts. In addition to freely distributing its radiant comfort to the room or person to be warmed, it can be placed in any desired position, and is not tied to so antediluvian a domestic adjunct as a chimney. That the radiator electric has come to stay is evident from the frantic efforts of the gas interest to maintain its hold of the doubtless remunerative heating branch of its custom.

In the matter of design of electric heaters some good results have been obtained with kryptol, a resistance material which glows like a fire but emits products of combustion. It is, however, on similar lines that experiment is now proceeding, and we may shortly hope for a substance which on the passage of electricity will emit heat but nothing else. For preference, the material should be incombustible, while it follows, as a natural consequence, that it must be cheap.

Shade and Reflector Data.

The interesting data on reflectors published in our American contemporary the *Electrical World*, and referred to in our last issue, has since been supplemented by additional particulars from the same source. The variety of shades and reflectors tested is very extensive, and in presenting additional details we can only make selections of the most important samples given. The authors of the tests, Messrs. Cravath and Lansingh, lay special stress on the necessity for using frosted bulbs wherever the eye is called upon to rest for long periods on the source of light. The advantages derived from the diffusion of the light, especially with an adequate reflector, are also strongly emphasised.

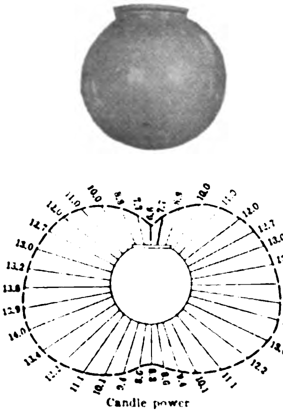


FIG. 1.
LIGHT DISTRIBUTION ABOUT A 16C.P. LAMP IN A GLASS BALL.

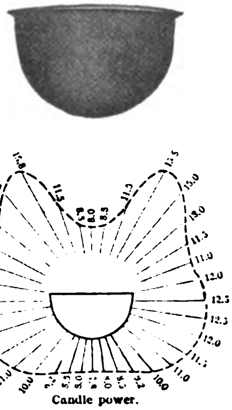


FIG. 2.
LIGHT DISTRIBUTION FROM A SAND-BLASTED GLASS BOWL.

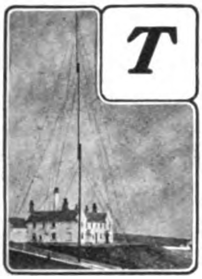
With electric lamps as distinct from gas lights it is quite customary to completely enclose the bulb in a glass globe or dish. Roof and wall lights and pedestals are frequently fitted with shades of this type as they conduce greatly to ornamental effect. Fig. 1 illustrates the illuminating effect of a glass ball containing a 16c.p. incandescent bulb. The light distribution is somewhat similar to that given by a simple frosted incandescent lamp, though the improved appearance of the globe must be taken into account. The absorption effect of the glass is clearly shown in the figure, and this result distinguishes the ball from the reflectors previously dealt with. A glass dish as used either in a basket fitting or ceiling light gives the light distribution shown in Fig. 2, and here the upward reflection from the glass is made clear. It is stated that this reflected light would be largely absorbed, and that an improved effect is obtained by fitting reflectors to the lamps themselves inside the bowl.

(*To be continued.*)

Several interesting articles are held over till next month, owing to pressure on our space.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

A Year of Telegraphy and Telephony.



THE telegraph and telephone branches of electrical industry during the past twelve months have been remarkable rather for expansion than development. By this we mean that increased use has been made of both, but no particularly striking improvements in apparatus are to be recorded. From the standpoint of expansion the telephone has made enormous strides, and more particularly so in America, and in the telegraph field the older wire systems have flourished quite irrespective of the threatened competition from wireless methods. Under this heading for review we are also including railway signalling apparatus, and fire alarms, as being legitimate species of communication systems.

TELEGRAPHY.

Telegraphic progress is mainly noteworthy for the attempts at introducing on a commercial scale type printing and writing telegraph systems. The Murray system continues to give satisfaction in London and Berlin, but as far as we know has not been extended elsewhere. The necessity for apparatus of this kind is coming to be removed by the introduction of the telephone, though it has undoubtedly a field in the distribution of news and commercial intelligence. The amount of ingenuity put into machines of this class is, however, deserving of wider application, but to all appearances it is in the field of commercial message telegraphy that printing telegraphs, by reason of their expense, do not merit wider employment. Mr. D. Murray has conceived a system of setting type by telegraph, and this if developed and adopted should revolutionize the distribution of news, for it is chiefly in newspaper circles that it would be valued. On the Continent the use of the Hughes and Baudot printing systems continues, but little, if any, attempt has been made to extend them. The simple Morse apparatus and code still predominate throughout the world, and are likely to do so for some time by reason of their freedom from breakdown either from electrical or mechanical causes. The ease with which the system can be multiplexed also greatly assists to maintain it in the field.

An interesting application of telephone methods to telegraph practice is instanced in the use of a switching board at the Central Telegraph Office in London, for the retransmission of local metropolitan telegrams. According to Mr. Gavey some 18,000 messages circulate daily in London, and previous to the erection of the board these were rehandled and transmitted on through the required local wire. The selector board now dispenses with this waste of time and the efficiency of the system is much increased.

While telegraph apparatus has undergone little or no change, cable manufacture has proceeded apace, and air space multicore cables are now available at prices which compete with rubber-covered wires. Underground leads between the great industrial and commercial centres are now regarded as indispensable, and the practical completion of the extension from Manchester to Glasgow will doubtless be but the preliminary of similar branches to Edinburgh, Newcastle, and the great towns of the north and west. In this country we are obtaining a unique experience of underground telegraph working which will certainly be taken advantage of by our telegraph confrères on the Continent and overseas. Cable manufacture has not reached the same degree of perfection abroad as now prevails in this country, and one is almost persuaded that a few enterprising Britishers might wake up the industry in America, say, if they liked to make the attempt.

Submarine telegraphy is principally marked by its employment of automatic apparatus and by the regularity with which it is being extended in all parts of the world. The standard ocean cable is still gutta percha insulated, though some lengths across the North Sea for telephone purposes are of the air-spaced paper-insulated type. Incidentally the surveying of the ocean bed for cable laying has been instrumental in adding materially to current knowledge regarding the constitution and character of the sea bottom, data which would not otherwise have been available.

In the railway world telegraphy is still relied upon for train control, while electro-pneumatic and electric power signalling is coming more consistently to the front. Several railway companies have taken up the former during the year, and the latter is being specially developed by the signalling department of another company. The first-mentioned system has, however, the great advantage of many years' experience, and of being standardised over the bulk of its details, so that experimenting with other methods is almost unnecessary. Automatic signals, especially on electric railways, have justified their claims to recognition and the majority of suburban electric train systems are now fitted with them. The control by the trains of the signalling is after all quite a simple matter and by the agency of electricity, and if need be pneumatic power, can be efficiently applied to any railway. The lines now operating with such systems in New York, Boston, Philadelphia, London, and on the Continent are running with complete satisfaction and can give considerably accelerated service. The provision of automatic train stops knocking out the circuit breaker and applying the brakes is a useful and almost necessary feature of the system.

Fire alarm service is now improved to a degree at one time considered impossible of accomplishment, and even small towns have an electrical installation. In this field progress has tended towards the improvement of apparatus and the provision of adequate indicating devices. Automatic alarms signalling the station are now quite indispensable in large establishments, and marked advances have been made during the year in this quarter. The thermostat is not much altered, and in fact is as simple as ever, but elaborate signalling systems are now available, one of these especially giving indications of line troubles, and also the nature of the trouble, whether fire or simply danger of it. Life and property is now concentrated within such narrow compass that prevention rather than cure of the fire danger is to be desired, and for this reason automatic fire alarms should be installed wherever possible.

WIRELESS TELEGRAPHY.

No more disappointing record of achievement in communication methods could be found than that presented by wireless telegraphy during the past year. Although great distances have been bridged and numerous systems put into operation, apparently successfully, the troublesome problem of selective signalling remains unsolved. Communication between ship and ship, and ship and shore, is perhaps in the most satisfactory condition, and is constantly being extended. The value of the system in storm times and when vessels are in distress cannot be over-estimated, and as long as interference is but a bare possibility, reliance can be placed upon it in emergency. A notable instance of rescue work was the saving of the crew of the Nantucket lightship, which broke its moorings and was driven out to sea. Atlantic transmission stands much about where it did, and the best that can be done in newspaper reports is the supply of Atlantic weather news. All the large companies, the Marconi, de Forest, Fessenden and Telefunken, have continued to establish stations in various parts, but there still remains that lack of confidence in any one method which must continue until something approaching secrecy can be guaranteed. Experiments with directed wireless telegraphy are still being conducted, and we have published from time to time articles by Mr. L. H. Walter, describing the work of Professor Artom in the production of elliptical waves, by which it is hoped to limit the area of etheric disturbance outside that desired for signalling.

Of new systems there seems no end, but these all are but modifications of the earliest forms, in that they are based on the same basic principle. Judging by the results of work in this promising and fascinating field of research, some authoritative statement is needed as to the laws governing the actions of so-called electric waves. Confusion still seems to exist as to the path followed by the waves, and whether etheric or terrestrial disturbances are the cause of the signals. A study of earth currents and the general phenomena associated therewith would, we think, do much to clear the present tangle of notions which surrounds the fundamental idea of wireless communication.

Transmission overland has received special attention from the de Forest Co., in America, and considerable distances have, according to reports, been satisfactorily covered. Communication with moving trains has also been announced and it was stated that a regular service followed as a result of the first successful attempt.

TELEPHONY.

In direct contrast to wireless telegraphy the development and application of the telephone has been phenomenal. To give figures in a case like this does not adequately convey the degree of progress achieved, though in this regard it may be said that between 1892 and 1902 the telephones in the United States had increased from 276,360 to 2,315,297. It could be safely said that this number in the succeeding four years will have doubled, though we have not the figures to quote. In the British Post Office system in 1905 there were 48,118 telephones, while the National Telephone Co.'s figures must exceed these very considerably. Telephones are now becoming household necessities, and it only needs reduced rates and cheap manufacture to bring this form of communication within the reach of all.

The central battery system is the standard for all new exchanges, and it is found in practice to give excellent results. Lamp signals at the board are also the rule rather than the exception, and magneto calling is giving place to the simple signal sent when lifting the receiver from its rest or hook. The manufacturing side of the industry has received particular attention, and special machinery is now employed which reduces the production of parts to automatic methods, and materially lowers the cost of manufacture. The actual cost of fabrication can in fact become a fixed quantity, any variation in the selling price being due to fluctuation in the raw material market. As a whole, telephone practice is now conducted on standard lines, and such improvements as are effected relate to minor details of instruments and exchange apparatus.

Automatic telephony, which seems the aim and object of telephone engineers, while it may also be vaguely considered desirable by the public, is being fostered rather more in America than any other country. During the year several large exchanges have been erected—their capacity being about 10,000 lines—in several Canadian and American towns, and, according to the organs of the industry, are giving complete satisfaction. Published figures attribute to one installation a saving of £6000 due to automatic operation, and in another case a dividend of 13 per cent. was paid by a small company using an automatic exchange. At Los Angeles an automatic service for extensions was recently installed and the management are so satisfied that the work of converting the entire exchange is being undertaken. The total capacity is 100,000 lines, and at present half these are in operation, so that the system will be of no mean dimensions for automatic working when completed. It is announced that automatic systems will shortly be introduced into this country.

A statement made in an American Telephone contemporary would encourage the belief that an instrument for making it possible to see the person conversed with at the telephone had been invented and was found to be successful. The inventor objected to disclosing details, as his patent rights had not been taken out. During the coming year we may hear something more of this attachment, which is known as the "Televue."

Telephone extensions and power transmissions naturally raise the question of poles, and some fears have been entertained in America that ten years would exhaust the supplies of that country. Although the tracks of wooded country are enormous, great damage is done yearly by fires and much loss thereby inflicted on the dealers in poles for supporting overhead lines. Mandatory orders from State Legislatures are suggested for the proper attention to wooded belts of land by their owners and the erection of a State bureau of forestry, together with the cultivation of forest preserves, are suggested as remedies for the evil, seeing that it is undesirable and inconvenient to rely entirely on imports of poles.

As an aid to the scouting arm and a means of staff communication in military operations the telephone proved its undoubted utility in the Russo-Japanese war, the victors employing instruments almost entirely throughout the campaign—at the battle of Mukden, for instance, in which Marshal Oyama handled nearly half-a-million men over a front of 100 miles for something like nineteen days solely by the aid of telephone lines skilfully laid by his staff of electricians.

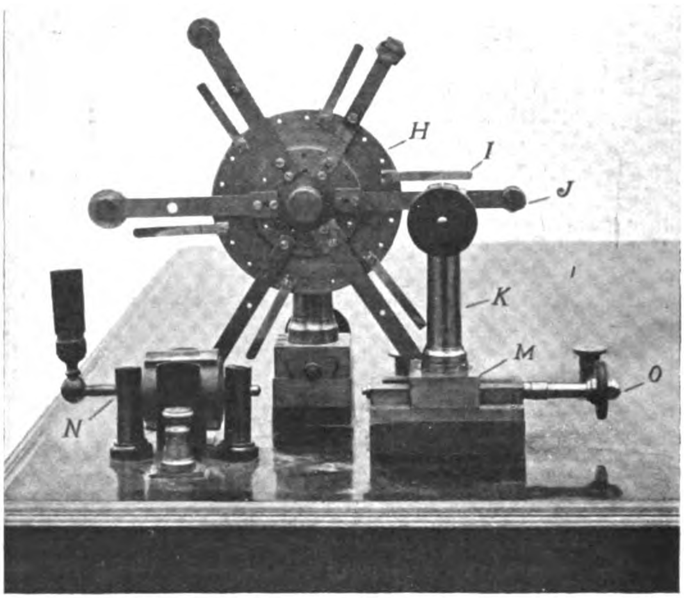


Fig. 1. Reed Disc and Mounting for Johnson Wireless Telegraph System.

Fires in telephone exchanges have occurred during the year, the most noteworthy being that at the Bank in London. The cause of this was due to a lead-covered telephone cable touching the contact rail of the electrified Underground Railway. Either the lead or the conductors themselves received the 500 volt current of the railway and an arc must have been started among the cable racks at the exchange.

The Johnson System of Wireless Telegraphy and Telephony.

Mr. A. T. M. Johnson.

Since Marconi's memorable announcement in 1896 that telegraphy without wires was commercially possible a great deal has been done and a greater written in this promising field of electrical enterprise. It should more truly be said that a great deal has not been done and still remains to be accomplished before anything like organized competition with existing telegraphic and telephonic systems can be undertaken. The problem of selective reception of messages has constantly baffled experimenters, and despite the regular flow of announcements to the contrary the claims of secrecy have failed to stand the test of constant experience. That little progress has been made is evident from the recent pronouncement of Sir William Preece in South Africa, with the British Association, that climatic variations and temperature variations upset the reception of messages in so-called selective systems. Coherers and resistance contact devices, electrolytic receivers and wave detectors alike come under the ban of this indictment, and if Sir William is correct, and there is no reason to doubt him, it might be conceded that as at present exploited wireless telegraphy is no more secret than the air.

We have, however, had occasion to inspect a system which contains all the elements of secrecy and by reason of its simplicity has everything to substantiate its inventor's claims. The fact that the system has not the benison of a Marconi or Lodge detracts in no way from its value, and the *amour propre* of the art need not suffer because Mr. A. T. M. Johnson, the inventor, makes no exaggerated claims for his transmitting and receiving devices. Wireless telegraphy has suffered much at the hands of Prince Bluff and to-day has passed from a wonder to a bye-word. The Johnson system however stands chiefly on grounds of simplicity. The apparatus differs little from that forming the main constituent of other systems. It includes battery, spark coil, and condenser, and with the exception of the special transmitting and receiving devices little else remains to describe.

The chief element of the system is the tuning device which forms the subject of the patent for the system. It is based on a simple law of vibration—Mr. Johnson was a professor of music for some years—regarding the tuning and use of metallic reeds. It is well-known that such reeds when tuned to the same pitch will remain in tune at all temperatures. Advantage is taken of this in the system under consideration, and as an enormous number of different known reeds can be made—as many in fact as the population of the earth—the difficulty of providing a sufficient quantity to secure secrecy is at once obviated. It is proposed to make large quantities of numbered reeds, each number representing a certain period or note. A directory would contain the names of parties whose instruments were fitted with reeds corresponding to the numbers, and as reeds similarly numbered will alone vibrate, the message though radiated broadcast is alone received by the station intended.

In practice the reeds are vibrated by an ordinary Rhumkorff coil, and a tuning reed is mounted beside the speaking reed, and the latter is so adjusted that the *former* vibrates freely in accordance with the law of syntonized synchronism. Both reeds are mounted on a disc which admits of the desired pair being placed in position against the core of the coil. In Fig. 1 the method of doing this is clearly shown. The coil itself is not in position and has been omitted for the sake of clearness. H is the reed disc; I, the tuning reed; J, the speaking reed; K, the contact pillar; M, the adjustable base; and O, adjusting screw. The speaking reed has a platinum contact and forms part of the primary circuit of the coil, current being led in at the pillar supporting the reed disc. N is a commutator switch of simple pattern. The side view of the apparatus, in Fig. 2, depicts the method of mounting rather more clearly, and shows how the reed disc is revolved by a small gear wheel and pinion. The contact screw, L, is adjusted until the tuning reed vibrates to the full extent, and at this moment the current in the primary and high voltage secondary are tuned to a period which will excite response in a similarly tuned reed and no other.

The complete receiving devices are shown in Fig. 3, and, in this case, signalling bell and sounding key are included. The receiving reed is shown at A, mounted between the poles of two horizontal electro-magnets in the receiving wire circuit. The reed is depicted without the adjacent contact springs which enable its vibrations to be transmitted to the local battery circuit and recorded on either a sounder or Morse inker. These springs have been omitted to indicate the position of the reed between the magnet poles.

The actual transmitting circuits comprise a battery, coil, condenser and usual switches, an earth connection, and an insulated capacity

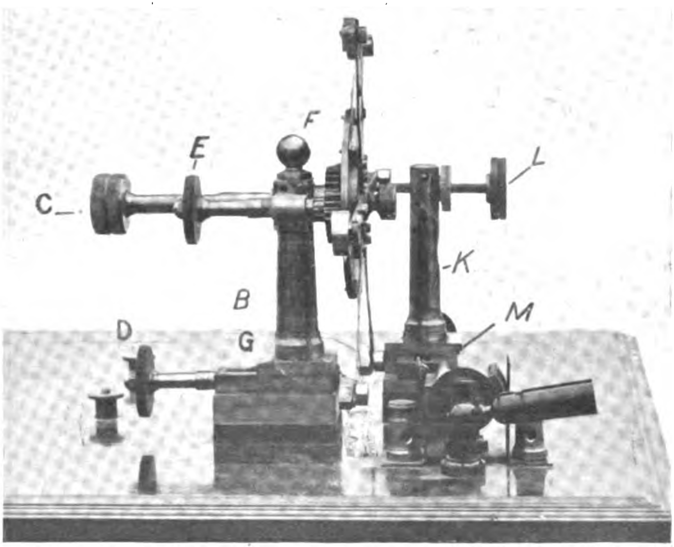


FIG. 2. SIDE VIEW OF REED DISC FOR JOHNSON WIRELESS TELEGRAPH SYSTEM.

—the two last being the respective ends of the secondary of the coil.

The inventor contends, with Dr. Pupin, that the waves produced follow the surface of the water, and do not travel through the ether. This is of course contrary to the existing theories of electric waves and is a matter upon which no definite pronouncement has been made by independent authorities on the subject. Certain it is that in the experiments conducted by the Johnson Syndicate no air wire of any description has been used over short distances. There are other wireless systems in which the earth is used as a connecting medium between stations and very considerable distances have been covered without any recourse to aerial conductors of any kind. With the Johnson system, it is claimed that the present distances bridged by existing commercial systems can be equally well covered. The experiments at Normans Bay which are in progress while we are in the press are expected by the inventor and the company's engineer to fully bear out both the secret service given by the system and its capacity for covering great distances.

The installation is housed in a Martello tower bordering the sea and includes, in addition to the apparatus mentioned above, a gas dynamo and a battery of accumulators. The generating unit is 1½kw. and is employed for charging the accumulators and lighting up the tower.

The principle by which the current can be tuned will have been made clear from the above description, and it remains only to state that by similar means a circuit can be adjusted and made suitable for wireless telephony.

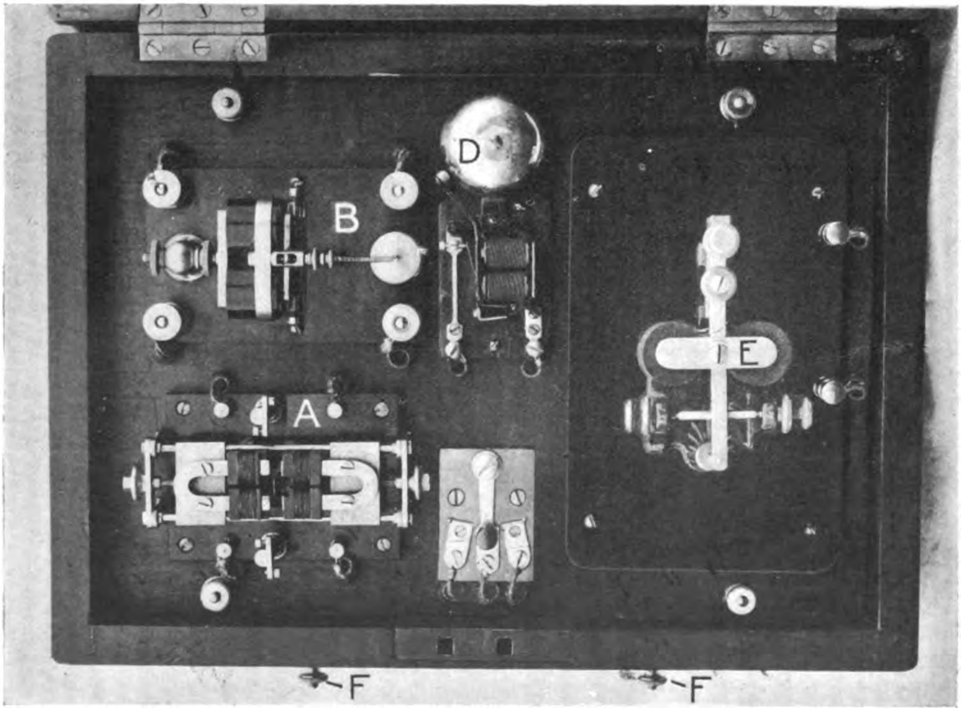


FIG 3. VIEW OF COMPLETE RECEIVING APPARATUS, JOHNSON WIRELESS TELEGRAPH SYSTEM.

In the present amorphous state of wireless telegraphy we cannot but hope that the Johnson system will substantially prove its right to general recognition in the experiments by which it now seeks to extend the highly successful and satisfactory results obtained over short distances. The extreme simplicity of the system and the low power required to send messages, combined with the all-important feature of selective syntony—these impress the mind at once with the feasibility of applying it universally at a minimum of cost and a maximum of efficiency.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

Electro-chemical and Metallurgical Progress.

Of the many branches of electrical industry that dealing with the production and refining of metals advances the most slowly. Processes which in principle are as old as the art itself have come to commercial perfection only after tedious delays and a long battle with prejudice. The most sanguine expectations of enthusiasts who foretold a universal revolution in the metallurgical arts have yet to be realized, and the most ardent champions of a good cause have been compelled to rest content with those small victories which tell in the long run but which are apt to become irksome. Progress has not been a matter of "forcing the pace," but rather a steady advance which gives initial stability and ultimate staying power. It is gratifying to note that no set-back has been experienced by concerns exploiting electric processes on a more or less small scale, and the production of aluminium, calcium carbide, lead and nickel continues satisfactorily, while copper refining, zinc and tin recovery are also flourishing. Marked expansion on the part of firms in the United Kingdom engaged in this province is checked for want of extensive natural resources and also by extreme competition of foreign concerns more favoured in this respect.

Iron and Steel.

Iron and steel production in the electric furnace presents the most hopeful outlook, and during the past year much good work has been done. It is now realised that extravagant claims were first made for the processes employing electrical energy to this end as to cost of production and competition with existing methods. Although the most encouraging results have been and are constantly being obtained, the blast-furnace and crucible processes have yet too firm a hold on the industry to be shaken from their position. The great iron and steel producing centres of England, the United States, and Germany can continue to compete with electrical methods while the coal supply lasts, unless hydro-electric power centres can be made the seat of manufacture. This of course is difficult to conceive, as, given a big margin to the good with electric production, the transport of ore to the reducing plant and the re-transport of pig and ingots would handicap the marketing of these at satisfactory competitive prices with the coal-produced article. The matter does not however end here, as the electric furnace has come to stay and will steadily take up the work of the older methods until they fall into disuse. That more than ordinary importance is attached to electric iron and steel is fully evident from the special Commission formed by the Canadian Government to enquire into the question. Mr. F. W. Harbord, metallurgist of the Commission, stated in its report that "steel equal in all respects to the best Sheffield steel can be produced either by the Kjellin, Héroult, or Keller processes at a cost considerably less than the cost of producing high-class crucible steel." The Commission went so far as to recommend the employment of one or other of the above-mentioned methods by Canadian iron and steel makers, and this in itself speaks volumes for the faith of experts in the value of the electric furnace in this field.

The manufacture of electric iron and steel has proceeded apace in France, Sweden, and

Italy, and with such excellent results that quantities have been imported into this country. The Sheffield steel-makers have now awakened to the immense possibilities before these newer methods, and though tardy in their enterprise, are taking the matter up. A Kjellin furnace is already in operation there, and the exclusive patent rights of the Héroult process for the British Isles have been obtained by another firm in that district. Mr. Harbord is fully convinced that electric smelting can compete with the crucible process and also open-hearth methods for higher qualities of steel. In the case of the Bessemer or open-hearth processes for the commoner steels he is not so sanguine, and has suggested a compromise whereby the melting is done by the present methods, and the subsequent refining, for which it is pre-eminently suited, he entrusted to the electric furnace. The higher temperatures of the latter, and which represent its most efficient condition, are all in favour of the adoption of this proposal. While experts are not ecstatic over the prospects of the electric furnace for iron and steel production, the action of certain of the Sheffield manufacturers is pregnant with great possibilities, and the next twelve months should witness interesting developments if the newcomers are given their due.

Metal Filaments.

A highly important application of the electric furnace has been made during the year for the production of metal and metallized filaments for incandescent lamps. In the case of the former the process which is applied to the metal tantalum by Siemens and Halske resembles that of the resistance furnace, the heating property of the current being taken advantage of. Before this metal can be satisfactorily worked it must be previously well fused, as impurities are thereby removed and a homogeneous body is produced. This is effected in a vacuum and is conducive to the best results in that a fine wire suitable for lamp filaments can be drawn out. The metallized filaments are the result of subjecting ordinary carbon filaments to the high temperature of the electric furnace. The filaments are packed in a carbon tube embedded in carbon powder, and subjected to a temperature of 3000 to 3700° C., at which point the graphite coating of the filament is changed, it being hardened and its resistance materially reduced. This interesting application of the electric furnace has resulted in the production of highly efficient incandescent lamps which will greatly improve the standard of electric lighting.

Atmospheric Nitric Acid.

An important application of hydro-electric power, which by the way is much favoured in electro-chemical and metallurgical work, has been made on a more extended scale in Sweden with a process for the fixation of nitrogen from the air. Professors Berkeland and Eyde have applied their process on a commercial scale at Notodden, near Christiania, where up to quite recently a ton and a half of pure nitric acid has been daily produced from the atmosphere. Natural water power is used, and current at 5,000 volts, fifty periods, is applied to produce a succession of arcs which bring about the fixation of the nitrogen. The product itself is largely used as a steriliser, and the existing extensive market is looked to for sales of the acid. In some quarters it is urged that the electrically produced article is not equal to the natural, which is exported largely from Chili, for manure purposes, while it is further claimed that the material is unsuited for the manufacture of explosives.

Ozone.

Another interesting electrical application in the atmospheric field is the production of ozone in quantities sufficient to merit its employment for disinfecting purposes. At present ozone can be produced by the electrical discharge in the air, by the electrolysis of acidulated water, and by the decomposition of pure water by hydrofluoric acid. Ozone has of course been known to chemists for many years, but only since a commercial use has been found for it has its production been promoted on organised lines. As a disinfectant ozone is pleasant yet powerful, and in the treatment of many germ diseases, such as cholera, anthrax, typhus, &c., it has proved very efficacious. Compact ozonisers can now be obtained at low cost, and for a small expenditure of electrical energy considerable quantities of the gas can be manufactured and distributed. The makers of this apparatus, which is self-contained and quite portable, claim that 1,000 cubic feet of air charged with five parts of ozone per

1,000,000 cubic feet can be produced for 1/600d. per 1,000 cubic feet. The provision of a fan ensures the effective distribution of the treated air.

Electric Welding.

The process of electric welding, which is one of the cheapest, simplest, and most effective for uniting metals, has now found its way into numerous industries, and curiously enough with little or no *éclat*. Chains, rails, and galvanised wire fencing are common products of the electric weld, while a more specialised article is the hexagon headed bolt, now accurately and speedily produced by electric welding machinery. The making of the printer's chase, a rectangular article which must be absolutely true and parallel in respect to its sides, is so cleanly completed by the electric welder that the finishing processes indispensable with the older methods are entirely done away with. The chief feature of electric welding is the comparative simplicity of the machine, which can be designed for special applications and attended to by unskilled labour. As a result the process is now largely employed for the manufacture of rings, steel tubing, parts of railway rolling stock, steel tyres, wheel rims, tools and smaller articles. In the matter of fuel consumption the gas and electric welds are about equal, but the great economy of the latter resides in the fact that the labour item is very greatly reduced. The power supply companies of Great Britain would do well to keep the electric welder prominently to the front.

Aluminium.

The production of aluminium still proceeds on a large scale, but the great hydro-electric centres of power in the world form the chief seats of this industry. Some ten works in all are operating, but of these the United Kingdom only possesses one, America three, and France, Switzerland, and Austria two each. An output of some 18,000 tons per annum represents the capacity of these installations, but further extensive expansions of the business are limited at present by costly refining processes, which tend to keep up the price of the metal. It is to be hoped that this embargo will be removed from a branch of electro-metallurgy which deserves all the success which it is possible to accord it.

Problems of Electro and Electro-Thermal Chemistry.

By R. THRELFALL, F.R.S.

(Concluded from p. 363, Vol. IV.)

NEW LAMP MATERIALS.

During the last year or two some minor inventions, which are nevertheless both interesting and important, have been reported. Amongst these stand out the magnificent series of researches by which Dr. von Bolton and his colleagues demonstrated the physical and chemical properties of the rare metal tantalum. Dr. von Bolton adopted the very original course of making a rod of brown oxide of tantalum by similar processes to those employed originally for the manufacture of Nernst glowers. Such a rod when heated by an alternating current in a space continuously evacuated is gradually converted into metallic tantalum, the oxygen being removed as fast as it is liberated. A fusion of the product in vacuo under the influence of an electric flame yields what may be considered to be pure tantalum. An alternative and more practical method is to purify the product obtained by reducing potassium fluo-tantalate (K_2TaF_7), by sodium, and finally fusing the metal in vacuo by the electric flame. In this purification advantage is taken of the fact that the impurity of the product obtained by reduction with sodium is mainly an oxide of tantalum. By melting the power in vacuo the oxide is partly dispersed as dust and partly reduced to metal. The smelting must be carried out in vacuo, for at the melting point tantalum combines with oxygen, nitrogen, and hydrogen, as well as carbon and most other elements, so it is hard to find an indifferent gas in practicable quantity. The tantalum powder is compressed into a block or into a Thoria or Zirconia crucible with a tantalum lining, and is made the positive electrode of an electric arc or flame; the other electrode being either a rod of tantalum or a piece of silver large enough not to melt owing to the heat being sufficiently rapidly carried away. As an alternative, two tantalum terminals act as electrodes for the arc, and the flame is directed on the compressed powder. It is convenient to heat the vertical side of a mass of compressed powder, for then the metal runs away as it melts and can be collected.

Metal obtained by this process contained nearly 99 per cent. of tantalum and was sufficiently ductile to be drawn into wire of 0.03 mm. diameter. If the metal contains carbon or hydrogen it becomes very hard, and is also hard if it is not perfectly free from its own oxygen compounds, more particularly after forging. The metal appears to withstand the action of acids (except hydro-fluoric) nearly as well as platinum, and is only acted upon by the alkalis when they are in the fused condition. The melting-point of the pure metal is between 2250 and 2300 deg., a fact which is turned to account in the application of fine tantalum wire as a glower in incandescent lamps. The specific resistance is not very high, however--rather more than half as much again as that of mercury—so that it is necessary to use a very long tantalum filament in incandescent lamps. The mechanical difficulties of the lamp manufacture appear to have been more or less overcome, and according to Dr. von Bolton an efficiency of 1.5 watts per Hefner candle is obtained at a temperature of the wire of 1700 deg.; near the melting-point the 1.5 watts is reduced to 0.3. According to the tests of Bell and Puffer, if electrical power costs from 3d. to 5d. per unit it would pay better to purchase tantalum (15 c.p.?) lamps for 4s. each than to use carbon filament lamps provided free of cost.

There are, however, some unexhausted possibilities about the carbon filament, and the General Electric Co. of America claim to have made a great improvement by graphitising the filaments at a temperature of 3000°-3700° C. A filament so heated is quite altered in appearance, and has a greatly-reduced resistance, but the point of greatest interest is that the filament has a positive temperature coefficient. The life of a lamp with these filaments is said to be considerably increased, and an efficiency of 2.5 watts per candle-power is claimed.

According to Wedding and others, the loss of efficiency experienced by a carbon filament of the ordinary kind is a real phenomenon, and the diminution of lighting power of an ordinary glow lamp is only to be partially accounted for by the blackening of the bulb, since if the filament be mounted in a clean bulb its light-giving powers are only slightly improved. It is not easy to understand why the efficiency of a filament should fall off with age. Another rival of the carbon lamp is the lamp with osmium filament, and in some ways it seems to me that the manufacture of the osmium filament is a more difficult achievement than the production of the tantalum wire. Osmium, according to Blau, is not sufficiently ductile to draw into a wire, and every chemist who has handled platinum metals regards osmium tetroxide with considerable emotion on account of its dangerously active reaction with the tissue of the eye. The usual analytical method for the separation of osmium—viz., distillation with aqua regia, always a tedious process—has been set aside, and osmiridium denuded of platinum by aqua regia is alloyed with tin or zinc and the alloy burned in air or oxygen, the osmium being collected probably as an osmate or osmite from the gases leaving the furnace. It is then a simple matter to obtain osmium in powder by reduction, and the powder is mixed with some organic binding material and the paste squirted through a jewel die. The filaments are then carbonised, and finally heated electrically in air and water vapour, so as to burn out the carbon and reduce the carbide of osmium. The resulting filament is, of course, very rough, and it must require great skill to avoid having spots of high resistance in the filament. The specific resistance is very low, and the lamps as ordinarily made only take 37 to 44 volts.

The efficiency for a life or 2000 hours is about 1.5 watts per Hefner candle, so that in this respect there is not much to choose between the osmium and tantalum lamp. Personally, I have some doubt as to whether existing sources of supply of either osmium or tantalum could support a large industry, but new supplies may turn up. Neither osmium nor tantalum are as rare as thorium was when the use of that element in the incandescent gas mantle was first attempted.

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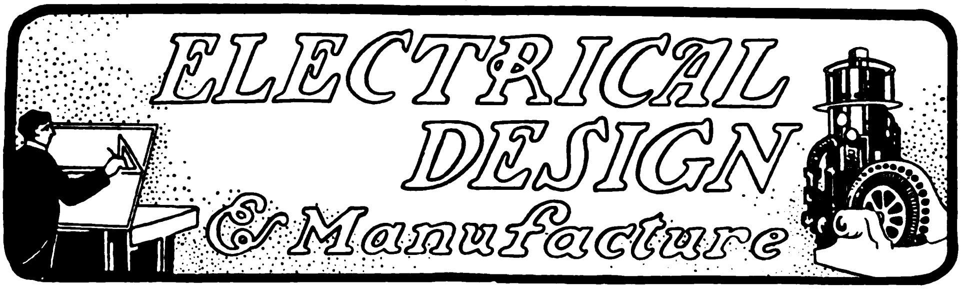


ELECTRICAL DESIGN & Manufacture

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Progress in Electrical Design.

THE general principles upon which the design and construction of dynamo electric machinery are based have, as was to be expected, undergone no change during the past year. The chief feature characterising the present status of this branch of the electrical arts is the extent to which standardisation has been carried and the consequent rapidity with which apparatus can be turned out from the manufacturer's works. This of course applies to the well established products of the industry, for which an extensive demand has been created. In the experimental constructive departments great activity has been displayed and many notable additions to the list of new plant and apparatus have been made during the year under review.

The design of generators, both for alternate and direct currents, is naturally influenced by the type of prime mover employed, and as the present outlook reveals a great variety of the latter machines, a corresponding distinction has to be made between the generators to which they are coupled. The flywheel type of dynamo both for a. c. and d. c. working, although still built, is not in anything like the demand now enjoyed by the turbo-generator. This latter, in the alternate current form, has undergone only those mechanical modifications which a larger output necessitates, and which are essential to safety on account of the high speeds employed for such heavy revolving masses. The fixed armature machine is standard, and both open and closed slots are used for the stator windings. The generation of high pressures direct in the armature windings is now quite commonly undertaken, 11,000 volts being about the limit in this respect. Continuous current dynamos for turbine operation have experienced a decided advance in that carbon brushes can now be safely and satisfactorily used for collecting from a plain surface commutator. In one type of machine this is accomplished by the provision of series intermediate poles having an entirely distinct magnetic circuit to that of the main field. No difficulty was experienced in keeping the brushes to the commutator face, the primary object being, by the adoption of the auxiliary poles, to keep down the armature reactance voltage, and thereby minimise sparking. This improvement should encourage the manufacture of large turbo-generators for direct currents, as the old serrated commutator and weighted wire brushes have never been considered quite a sound mechanical job.

The motor branch of manufacture has been notable rather for its output than any radical or striking departures or improvements in design. Ventilated, semi-enclosed, enclosed and open type machines are the order of the day for direct current, while a.c. machines being indifferent to changes of their environment remain as unprotected as to their internal economy as ever. The induction motor has been made the subject of much literature, illuminating and otherwise, though it may be said in justice that this type of machine has been brought as near perfection as it is possible to get it. Its extreme simplicity lends it to almost automatic production, a circumstance largely contributed to by the excellence of the standard data regarding its design. This applies more particularly to the three-phase motor, as one and two phase machines of this type are not so extensively manufactured. One - phase machines for traction purposes are of course now familiar, but these are all commutator machines and are mostly suited for operation by direct current. A feature of the year has been the attempt to revive the interpole pole motor for variable speed work, and this is being done with some success in several machines on the market. That a simple shunt motor with rheostatic control is a desirable thing for multi-speed purposes is evidenced by the introduction of these machines and their continued application to industrial purposes. Whether the additional work of manufacture and consequent increased cost will militate against the development of these motors remains to be seen. Interpoles are after all a somewhat drastic compromise which experience alone can justify or condemn.

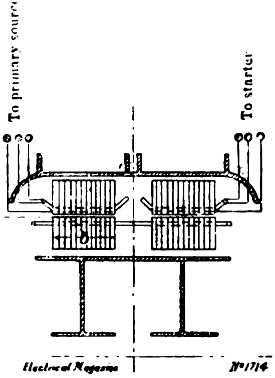
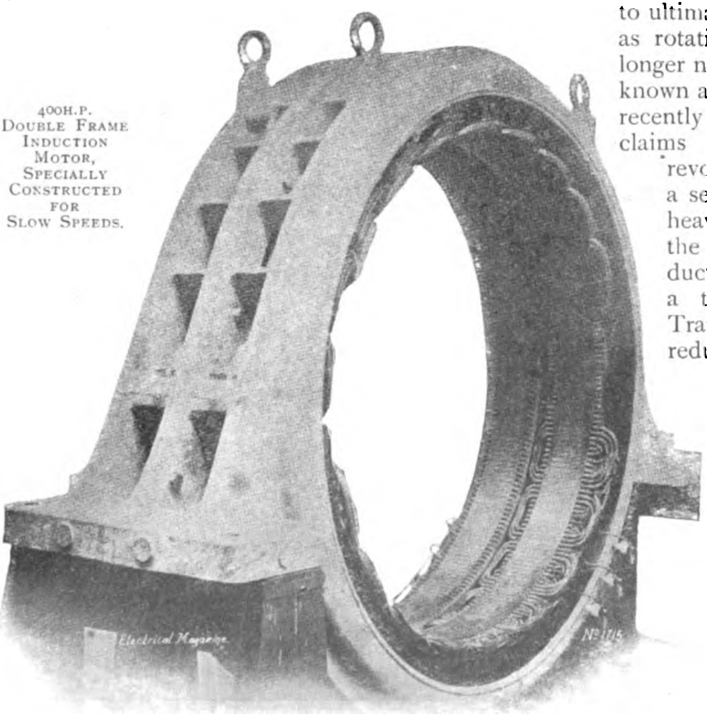


DIAGRAM OF STATOR AND ROTOR SYSTEM OF DOUBLE FRAME INDUCTION MOTOR.

Converting machinery for sub-stations has been subjected to little or no change in the year, that is in respect of the standard motor generator and rotary converter types of plant. There seems to be about equal preference given to the induction and synchronous types of motors for the former machines, but in some quarters the claims of the synchronous machine to superiority are regarded as somewhat overdone. The induction form of unit, by reason of its mechanical construction and electrical stability, is likely to ultimately survive until such time as rotative converting plant is no longer needed. A type of machine known as a "permutator" has been recently introduced, and has novel claims to attention in that the revolving portion is reduced to a set of brushes only. All the heavy parts are stationary, and the relative motion of conductors and field is secured by a three-phase rotating field. Transformers are needed to reduce the line potential in the same way as is done with rotary converters, a full load efficiency of 93 per cent. is claimed, and a power factor of ninety-seven. It is stated that the machines cannot be thrown out of step owing to the absence of heavy moving parts, and a further advantage is the economy of floor space, a 150kw. machine having a maximum diameter of 3ft. 3in. The machines have a vertical shaft, and for this reason occupy but

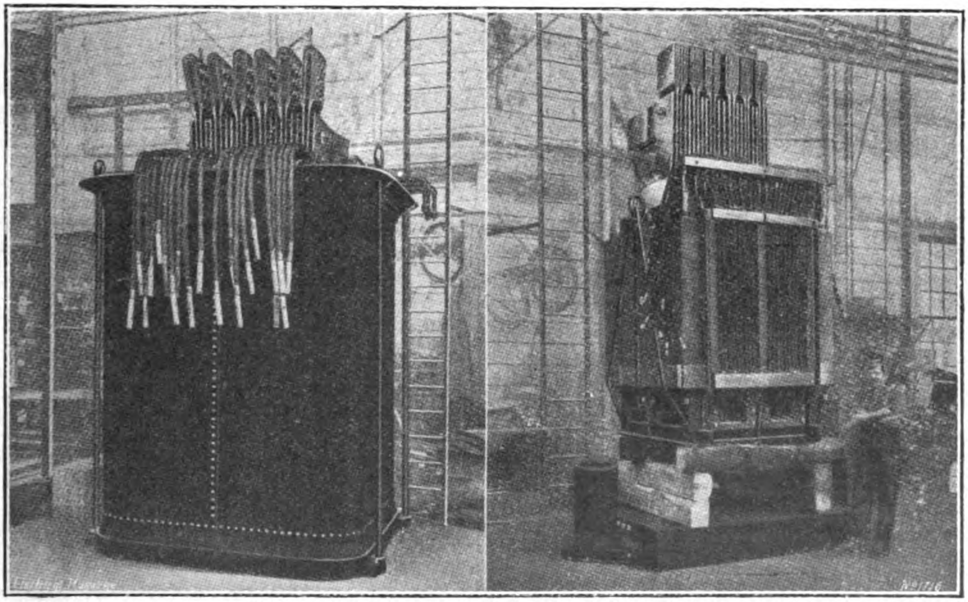


400H.P. DOUBLE FRAME INDUCTION MOTOR, SPECIALLY CONSTRUCTED FOR SLOW SPEEDS.

little floor space. No special arrangements are made for starting, as the operations are confined to the closing of a single switch—that controlling the small motor revolving the brush gear.

The construction of large induction motors for slow speeds, to facilitate direct connection to pumps, winding gears, &c., has been undertaken on a considerable scale on the Continent, where such machines are to be frequently met with in deep mines and out of the way places. Motors of this type, unless specially designed, are apt to be very large, as a great number of poles must be provided, and, further, there are limiting factors to the increase of diameter and weight. A very ingenious method of building a smaller and more compact motor is adopted by a continental firm by which two distinct stators and rotors are assembled within one carcase and on one shaft. One stator is connected to the primary mains, and the other to the starting resistances, the rotors being connected in series, but having no connection with the external circuit. The adjoining diagram and illustration (p. 38) will make the construction quite clear. It will be seen that the second stator, in acting as secondary to the first, is magnetised only with frequency of the slip, and iron losses become negligible. Half the total iron, that of the primary stator, is also only magnetised with the full frequency of the line current, and hysteresis losses and eddy currents are accordingly reduced. The design is so effective that comparative small diameter motors, which can be sectionized for transport, are now built for speeds down to 80r.p.m. and outputs up to 400h.p.

More than ordinary attention has been given during the year to the subject of ***Solenoids for Switchgear*** purposes, in fact specialists have already established themselves in some quarters, and are prepared to advise on the design and construction of such apparatus. This is only as it should be, because the electro-magnet when employed in this particular field needs care and skill both in design and manufacture, and only extensive experience can give good results. In the same category may be included heavy magnets for the lifting of iron and steel parts in works and stock yards. A very mixed reception has been given this device by those British manufacturers to whom it would prove valuable, though it is very largely used on the Continent and in America. Solenoids are now playing a most



THE LARGEST TRANSFORMER IN THE WORLD.
Constructed by the Stanley Manufacturing Co., Pittsfield, Mass., for the Pittsburg Reduction Co.
On the secondary side it delivers 20,000-80,000 amperes at 20 volts.

important part in electrical operations, more especially the field of control, and it is to be expected that they will be even more widely employed as industrial electrical applications are extended.

Transformer Design has maintained a vigorous condition during the year, and much of the success of the world's great hydro-electric transmission schemes is due to the care with which these important accessories of the system are proportioned and manufactured. Some discussion has occurred as to the relative merits of the oil and air cooled types, but the tendency seems in the direction of the oil-cooled device as the most efficient and reliable. Precautions for isolating the oil in case of fire are regularly taken with the very large units, and these seem to do all that is considered advisable. Efficiencies are of course, well maintained, ~~and~~ modifications in design are of a mechanical rather than electrical nature.

Investigation in the field of ***Insulating Materials*** has been productive of much valuable data, and in this branch of the industry a much stronger position is noticeable than has hitherto existed. Numerous compounded insulating materials are on the market, and each seems to have a special field to which it is peculiarly adapted. In the higher ranges of voltage it is particularly noticeable that the very best results can be obtained with the insulation now put forward for the purpose. Similarly high tension testing apparatus has been much improved, and disruptive and capacity tests with varying frequencies are now possible with adequate and simple apparatus. The design and manufacture of insulators for transmission circuits have also been greatly improved, and makers have done wonders in the perfecting of large insulators by which former voltage limits have been pushed considerably higher. It is of course recognised that this indispensable element of power schemes at present limits the pressure at which transmission can be effected.

Considered from all points of view, this section of the electrical industry may be regarded as being particularly active, as it includes within its borders many young minds filled with new ideas and ever ready to apply these to the good of the common cause. Too much publicity cannot be given to the results of investigation in this field, nor can any excess of effort ever outrun its enormous possibilities. All praise is due to the heads of the designing departments of great manufacturing interests for the frank manner in which they bring forward data, and it is needless to say that the technical press is always willing to co-operate with these good intentions by giving every possible publicity to the information supplied.

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An Electric Accelerometer.

By R. B. OWENS.

THE advent of the electric motor as a competitor of the steam engine, especially in the traction field, has given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train-mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train-mile, car-mile, nor ton-mile suffices, even when coupled with a speed factor as a basis of estimation and analysis, now when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate, and reliable means of measuring acceleration is urgently demanded—a means at least comparable in simplicity and accuracy to those employed in the measuring of the quantities of which it is the second and first differential with respect to time. The measurement of length is familiar to all. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the piece whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant coefficients as shown in Fig. 1.

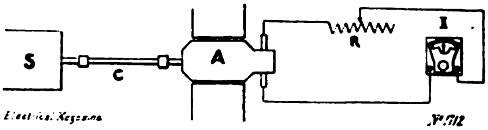

FIG. 1.

S is the shaft whose velocity is to be measured. C is a mechanical coupler. A is the armature of a small permanent magnet or constantly excited continuous-current dynamo wound so as to have a negligible reaction within the limits of its use. R is a variable non-inductive resistance, and I is a zero-centre direct-current ammeter. The reading of I will be proportional to the speed of S and by adjusting R can be calibrated in the revolutions per minute, feet per second, or miles per hour as desired. As the current through I is proportional to speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting in the circuit with I a transformer T with its secondary connected, for purposes of adjustment, through a non-inductive resistance R_1, to a zero-centre, direct-current voltmeter V (see Fig. 2). The reading of the voltmeter V will then be proportional to the acceleration, positive or negative, of the shaft S.

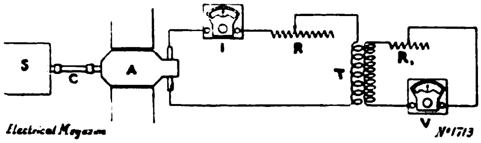

FIG. 2.

Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio, as the secondary induced voltage is necessarily small and the voltmeter V must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature A at different constant speeds, as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature A by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time. With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line whose slope will be constant and equal to the acceleration and to the constant reading of the voltmeter to within a constant.

In some tests made in the writer's laboratory not long ago, A (see again Fig. 2) was the armature of a small, low-voltage, separately excited, direct-current generator; S the shaft of a three-horse-power, separately excited, direct-current motor to whose armature by a potentiometer arrangement a steadily increasing or decreasing voltage could be applied; I and V Weston ammeter and millivoltmeter and T a small lighting transformer with a transformation ratio of twenty, and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston direct-current ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work, both steam and electric, and is applicable, of course, in many other connections.—(From a paper read before the Canadian Civil Engineers.)

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Iron and Friction Losses in D. C. Machines.

THE introduction of variable-speed d. c. motors with intermediate poles has created a demand for some quicker method of determining the iron and friction losses at the different speeds than is possible by the Swinburne and Hopkinson tests. As is well known with these latter, a considerable number of tests is needed to give a result at a certain speed, and although the results are beyond question, the time involved militates against the employment of the means to obtain them. The Hopkinson method gives better results for the class of motor referred to, but is too tedious a process for regular use with large quantities of motors.

In view of these facts, interest attaches to an article on the subject recently contributed by Mr. T. H. Page to the *Electrical Review*. Mr. Page goes closely into the subject, and explains how, with a modification of the Hopkinson test, excellent results can be speedily obtained. Two machines of similar type and size are coupled together, the one, run as a motor, driving the other, which is unexcited. The motor speed is varied by the shunt excitation, and simultaneous readings are taken of the armature amperes and volts, the excitation and speed. The fields of the two machines are then put in series across double the normal voltage of one machine and a similar test made, except that the two fields are now excited. From these two tests two curves are plotted, connecting watts lost (exclusive of C^2R losses) with r.p.m. In the first, at any speed in r.p.m., the loss W is equal to the friction losses of the two machines, plus the iron loss in the motor. In the second are the same losses as before, plus the additional generator loss. As the machines are of similar size, type and voltage, the field in both will be approximately the same if the same exciting current is flowing through the field coils. This condition was fulfilled by putting both fields in series, and in the second test the increased loss is due to the iron loss being doubled. Subtracting the results obtained from the first test from those of the second, the iron loss at any speed of the motor is given, and by subtracting the iron loss from the results obtained by the first test the friction losses of the two machines are determined. By halving this the friction loss of one machine is given, and by these two simple tests the whole separation is effected. Mr. Page points out that this result could be obtained by the first two tests of the Hopkinson method, but states that errors would be introduced by the difference in the friction losses of the two machines, more particularly at the higher speeds of the motor. In the new method described above, errors due to field differences in the two machines can be eliminated when both have the same exciting current.

The Need for Condensers.

The development of alternating current motors both single and polyphase has been much handicapped for want of a good condenser of large volt-ampere capacity. A variable capacity and inductance in a motor circuit permit of torque variations which increase the sphere of utility of a motor of the induction type, and would admit of its application in fields now the exclusive monopoly of direct current machines. If we recollect aright, Mr. Ferranti was among the first, if not the first, to advocate the production of condensers and their employment with one-phase motors. This advice was rendered at a period in which one-phase currents were generally distributed, and it was desirable that motors should be used from such supply mains.

At the present juncture the one-phase railway motor is all the fashion, but with the exception of motor-generator systems, commutator motors are being installed on lines adopting this system. The many good features of the induction motor single it out for special notice in this field, and reliance must be placed on the designer's skill to evolve a machine which will retain all the desirable points of such motors and yet be applicable to one-phase circuits. There seems to be nothing which would suggest modifying the now familiar construction of the induction motor, consequently any alteration in its characteristics must be made by the aid of means external to the motor itself. As indicated above, the use of an inductance and a capacity in the starting circuit admit of a change in the torque of the motor. The provision of the inductance presents no difficulty, but in the matter of the capacity no compact and efficient form of condenser has yet been developed for commercial service. In a recent issue of *Elektrotechnische Zeitschrift*, M. Dalemont referred to some tests conducted with three-phase motors on one-phase circuits, and although the machine did not exceed 1h.p. the results point to marked advantages of the method of connection for larger types if the condenser problem can be satisfactorily solved. Fig. 1 depicts the connections of the motor, I, II, III being the three-phase windings, C a condenser, R an inductance, and AB one-phase mains. The motor was tested as a polyphase machine at first and showed an efficiency of 50 per cent. at full load and a power factor of 0.83, the latter, a very steep characteristic in the plotted result, showing a very low average over the range of load. As a one-phase motor the efficiency was not quite so good, but the power factor was exceptional and was fairly uniform throughout the different loads. The power consumed was also lower with the one-phase machine, especially at and near about full load. The difficulty with the arrangement, however, lies in the condenser, and if the induction motor is to rival the series machine in one-phase railway schemes and in the industrial field, greater attention must be paid to condenser design.

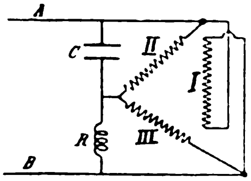
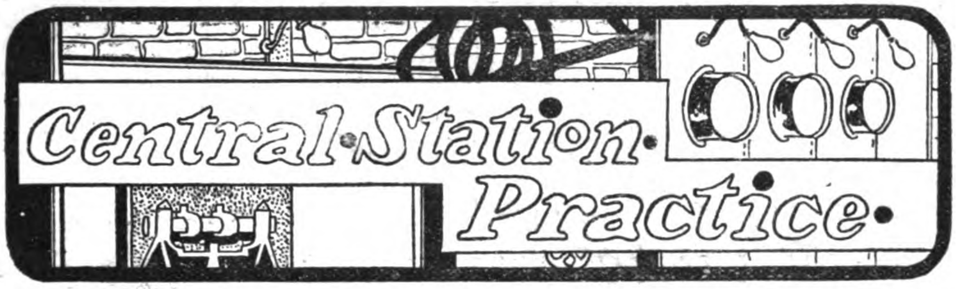


Fig. 1.
Diagram of Connections for Three-phase Motor on One-phase Circuit with Condenser.



Central Station Practice

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

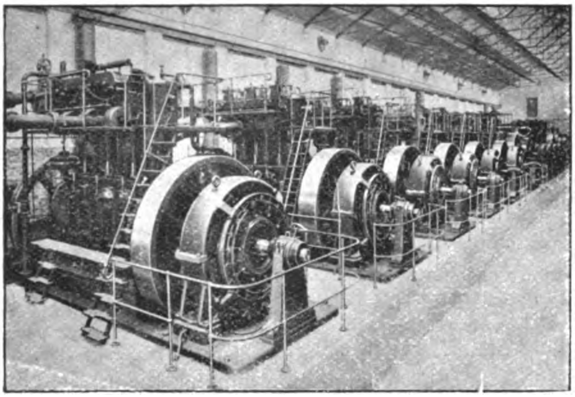
A Year of Central Station Work.

A DISTINCT change has come over the conduct of central stations in the last few years, but more particularly has this been noticeable during the last twelve months. The standardisation of plant, the ease with which extensions can be carried out, and the now almost automatic operation of stations—all these have tended to subject the engineering portion of the undertaking to the business-getting and commercial side, with consequent increased attention to and activity in the latter. This is but the natural outcome of events, as the chief object of the station is to *sell* rather than *to make* electrical energy, and now that good machinery is available and competent men are plentiful to tend it, the policy of sales must predominate that of engineering and a vigorous campaign be promoted to get customers on to the mains.

Boiler House Practice is now almost inseparably associated with mechanical stokers, superheaters, and CO_2 recorders, in fact the many little improvements made possible by research in this province have contributed largely to the reduction of works costs. thus clearly demonstrating that attention to details is productive of benefit to the system as a whole. Even the smallest stations are finding that the use of CO_2 recorders, for instance, affords a tangible incentive to the stokers to look after their fires. Nothing beats a recording slip to act as a stimulus to workmen and promote healthy competition among them, thereby increasing their interest in the plant under their charge. Flue gas analysis has come to be regarded as equally indispensable to the steam-raising department of a station as the feed pumps themselves. The temperature of flue gases is also another matter which now receives attention, and good pyrometers make it possible to record changes in this quarter and check the performance in the human or mechanical stoker. In the matter of superheaters extended experience with the additions to the steam-raising plant justifies their employment and makes for continued progress in design and manufacture. The steam turbine has done much to encourage superheating, but more marked economies are possible with reciprocating engines when run with superheated steam. Coal-conveying plant is more common than not in stations now, and automatic weighers in the delivery chutes are the simplest possible form of check on fuel consumption which could well be devised. Refinements of this kind have replaced the older perfunctory methods, from which accuracy was conspicuously absent. When it is considered that every pound of coal means 10lbs. of steam evaporated promiscuous waste is to be avoided and rigidly economical methods should be enforced.

Engine-room Methods have undergone little or no change, and much the same policy as of yore directs the general routine. Plant troubles, either electrical or mechanical, are happily rare, though on occasions unusual skill and coolness is required to cope with sudden difficulties. The parallel operation of dynamos of all types is now generally followed and is found in practice to give eminently satisfactory results.

On the Distributing System there is generally greater excitement than at the works,



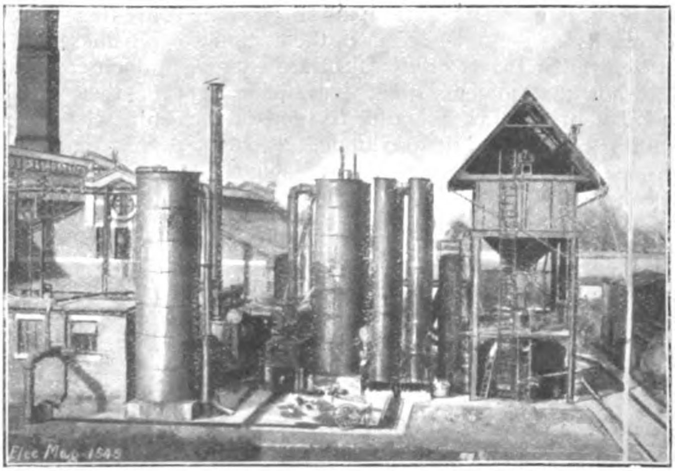
A TYPICAL GAS-DRIVEN CENTRAL STATION AT WALTHAMSTOW.

The generators are all connected to gas engines of the Westinghouse high-speed type.

and "incidents" will sometimes follow each other in disconcerting succession. Here more than anywhere the greatest clear-headedness is needed, as breakdowns involving huge financial loss are likely to occur. Even a few moments' interruption may cause great inconvenience and inflict customers to an extent involving heavy claims for damages. It is still a matter for some doubt that cables are regularly and systematically tested, even in large works, consequently the tiny faults are permitted to develop into greater until a wholesale breakdown results. Neglect in this quarter is directly attributable to the engineer in charge, as there is no lack of precautionary methods, nor can a dearth of good instruments be pleaded as an excuse. Both portable testing sets and panels suitable for recording or indicating the leakage conditions of the system are now marketed at reasonable figures. While jointing methods have much improved, there is still a need for reliable data as to the efficiency of the iron box with screwed or pocket glands. The boxes now laid may answer for a time, but there is a danger that they may be a fruitful source of trouble as time goes on.

Meter Departments are now conducted on more systematic and organized lines, and a competent "testing engineer," who quite often combines the functions of electrician, chemist and metallurgist, is now generally to be found at the head of this branch of the undertaking. Too much attention cannot be paid to the accuracy of meters, as deficiencies in this quarter may seriously affect the revenue of the concern. The growth of prepayment meters is an encouraging feature of an obvious desire to tempt the small consumer on to the mains, and the many improvements made give the chief engineer a fairly wide choice of types. Model lodging-houses and industrial settlements have by experience been proved highly profitable, and it is desirable that such customers be connected up to the supply. Landlords will generally bear the initial cost of installation.

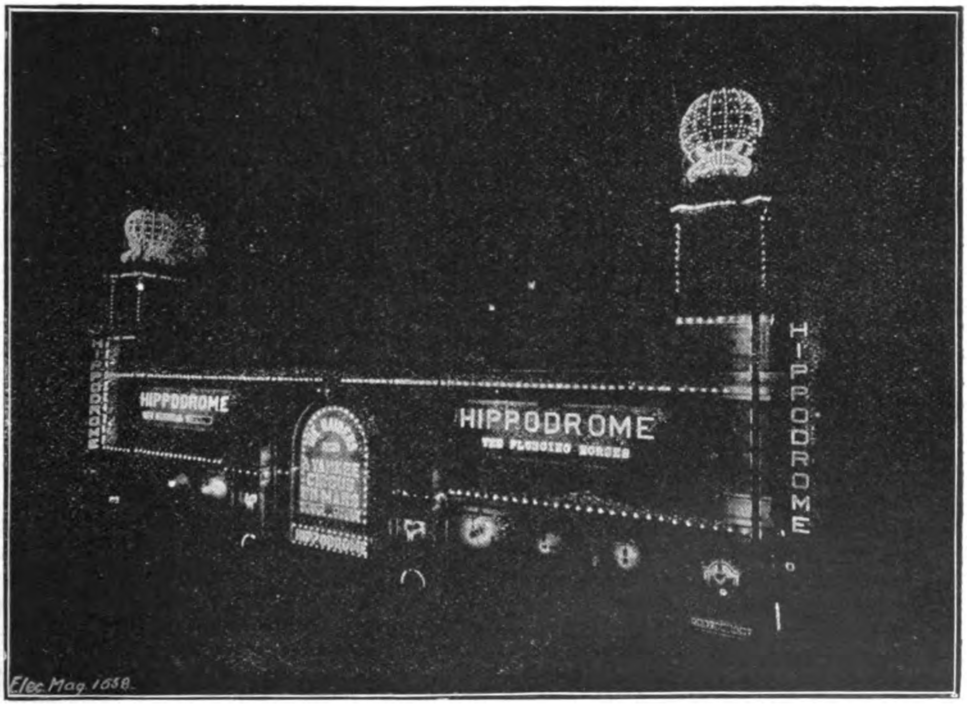
In Street Lighting, matters have been greatly stimulated by the introduction of improved flame arc lamps which form an effective weapon with which to fight the gas mantle. The virility of gas companies in this province is something which electrical engineers might well copy, as there is an undoubted need for some show of front on the part of electric lighting for streets as a powerful and economical rival of gas. It



A MODERN CENTRAL STATION GAS PRODUCING PLANT.

This is what may be expected in the near future in station practice—bituminous coal gas producers and gas engines driving dynamos direct. The plant illustrated has been erected at Reading, and will furnish 1800h.p. to direct-connected gas driven generators.

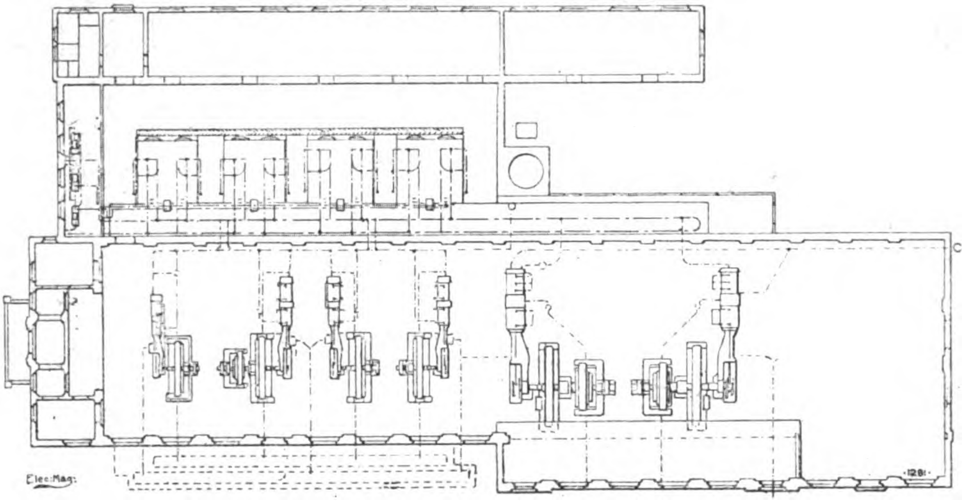
is not enough to be "cocksure" and remain inactive because it will be a win for electricity in the end. Central station engineers are too apt to be over-ridden by their committees on the rival interests themselves, and because street lighting is not financially all that it might be, or that other customers are to the undertaking, they allow matters to slide. The specious and too often unscrupulous methods of gas concerns are to be strictly tabooed because there are cleaner and safer methods by which the full merit of electric street lighting can be brought to the front. Despite this apathy, however, much is being done to demonstrate the superiority of the better illuminant, and it will not be long before the fallacies of gas are exposed if a vigorous policy is adopted and strenuously pushed into the proper quarters.



THE BEST FORM OF CENTRAL STATION ADVERTISING.
An effective sign display at night brings business to a central station, when full advantage is taken of it.

Incandescent Lighting has claimed more than usual attention at the hands of central station men, the world over, and from all quarters it is to be noticed that customers are being encouraged to discontinue the use of blackened or over-run lamps. Exchanges can be effected at a central office or the works, and consumers are by this method made to take an interest in their installations. The advertising value of this policy of efficient illumination is immense, and will do much to heighten the opinion of electric lighting. The introduction of lamps of the tantalum, osmium and metallized filament types need be regarded with no apprehension by central stations, as despite the reduced consumption of energy, the effect on the system will be beneficial rather than otherwise. The gas companies had a similar situation to face at the appearance of mantle burners, and their returns show enormous increases as the result. The situation, as regards cost of lamps, is hardly on all fours, but it has been stated in America that it would be dearer to receive carbon filament lamps free than to purchase the newer and more efficient types. The extent to which the new lamps have already been taken up is at least an encouraging sign of good business in them, in spite of their greatly advanced price.

On the Commercial Side of the station, the first great question is that of tariffs. The



A Type of Central Station now gradually falling into disuse.
Turbo-Generators and Gas Engines are very much to the front at present.

fixing of these is something in the nature of a Chinese puzzle, and one which even now is not satisfactorily solved. If last year's meetings of the Municipal Electrical Association are any index of coming events, the maximum demand system will not survive many years. By maximum demand we mean that method of charging which involves the use of indicators. That a system of tariffs will be formulated, based on the principle of maximum demand, is beyond question, but this will be but a step to common flat rates for lighting and heating and power. Nothing will do more to stimulate the uses of electrical energy than a simpler system of charging. The growth of large stations permits of the adoption of flat rates, and the sooner they are put into force the better for the art of electricity supply.

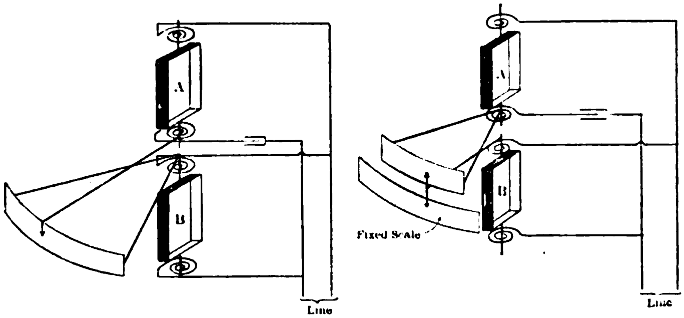
We now come to that hitherto much neglected branch of central station undertakings, to which we have briefly referred at the outset, ***the Sales Department.*** It is an encouraging sign of progress that the great value of publicity for the system is being more widely recognised, and innumerable methods are being employed to court it. Advertising is almost valueless by itself, but, similarly, canvassing is rendered negative if conducted without paving the way by disseminating printed information. What is needed is a judicious combination of both with either a permanent or occasional exhibition thrown in. Money spent in this way will always find its way again to the station exchequer, and a very little care and judgment will effect the desired combination between advertising and canvassing. An elaborate printing establishment is not required, nor is it necessary to put on a corps of tophatted popinjays. Effective literature can often be obtained from outside sources. and good commercial electricians are to be had as solicitors for custom. The past year has witnessed the inauguration of publicity campaigns in this country, while in America the thing is done with characteristic thoroughness and dash. Engineers might do worse than apply to the heads of the larger American stations for copies of their "business-getting" literature, and, from the stations within the Edison organization at least, they would be assured of interesting ideas and information. We want, however, to see a strong combination put up to refute the mendacious statements of the gas interest, and by honest campaigning and a bold declaration of the facts electricity supply will be freed from a yoke which its rivals have only too easily attached to it.

Frequency Meters.

It may not be generally known, but an ordinary A. C. ammeter in circuit with a condenser is a frequency meter, if allowance be made for voltage variations. The design of an instrument operating on this principle must make provision for this latter feature, otherwise a true reading will not be obtained. Mr. J. F. Begole of the Wagner Electric Manufacturing Company, St. Louis, has produced an instrument which embodies this particular function in a very ingenious manner. The apparatus was recently described in the *Electrical World* by Mr. A. S. Langsdorf, who independently conceived the same device. The principle referred to above is expressed by the term

$$2\pi f EC \text{ amperes,}$$

where E is the E.M.F. (sinusoidal), f the frequency, and C the faradic capacity of a condenser. For a given value of C the ammeter readings will be proportional to the frequency, if, as we have already said, the voltage E can be kept constant. In this case the ammeter scale could be calibrated directly in cycles. Allowance must however be made for voltage variation, otherwise pressure fluctuations will be recorded as frequency changes. This allowance is made in the instrument described by pivoting the *scale* on a line coaxial with that of the pointer. By making the motion of the scale, due to voltage changes, equal to and in the same direction as the needle, the relative motion between the two will give an accurate reading. This compensating scale motion is obtained by attaching the scale to a bobbin constructed like an ordinary voltmeter and connected across the line. The adjoining figures clearly depict the application of the principle in practice. Bobbin A carries the pointer, and is energised by the condenser current, while bobbin B, placed either above or below A, is made to actuate the scale. The presence of this bobbin admits of voltage indications being made, and this is done in the manner shown in the right-hand figure, the additional fixed scale and pointer extension being the only extras.



Diagrams of Suspension and Connections of Frequency Meter.

This instrument is very sensitive, and will indicate frequency changes of the smallest character throughout a considerable range. It is a very simple and beautiful application of the well-known fact that the alternate current strength flowing through a given condenser under a given impressed voltage, increases directly with the frequency.

Ground Detectors and their Uses.

THE old days of cut-and-try and column of smoke methods on networks are fast going out, and an era of accurate instrumentation is taking their place. At one time grounds on a system made themselves felt by a groan from the dynamo or the blowing of a fuse, and this of course only occurred after the small initial trouble had developed into a "busting" fault. Thanks to the skill and care of the instrument maker, however, and the application in practice of his devices, the central station engineer can cover his switchboards with indicators to signalize the slightest disturbance of the system. No better example of progress in this field can be found than the ground detector, and in this regard we may refer to an article in the *American Electrician* which dealt somewhat fully with the subject. The author, Mr. J. T. Coe, describes a number of familiar detecting devices, such as the simple voltmeter and lamps in series for direct current, and also covers the a. c. field very thoroughly. His references to the use of current transformers for voltmeters and lamps are interesting, but they are somewhat nullified by the recent introduction of static indicating devices for high voltage circuits.

For instance, the detector shown in Fig. 1 has four fixed vanes arranged round a moving vane of aluminium attached to a pointer. The fixed vanes are connected diagonally in pairs, and each pair is charged statically by one of the line wires through a condenser. The movable vane is connected to earth. The fixed vanes act

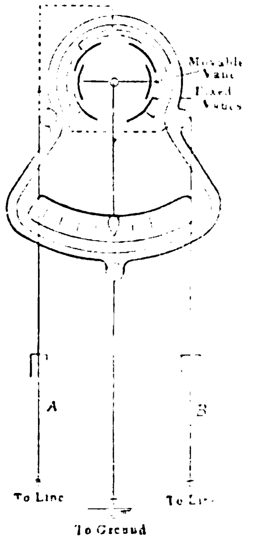


FIG. 1.

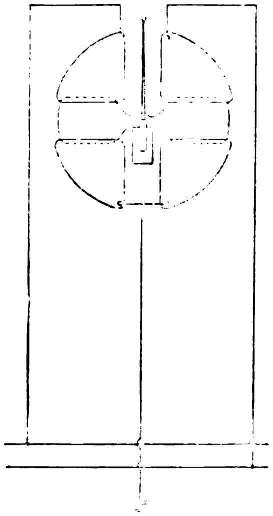


FIG. 2.

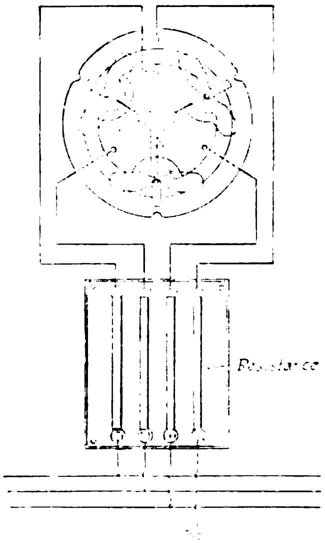
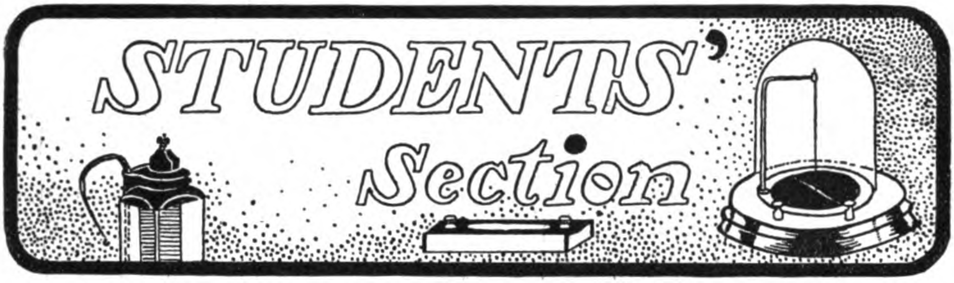


FIG. 3.

inductively on the movable vane so that the stress produced by each pair is equal, but opposite. The movable vane consequently takes a position midway between the fixed vanes, which position obtains whether the condensers are charged or not, so that the pointer rests at zero, indicating no ground. Should a ground occur the primary plate of one of the condensers and the movable vane become connected electrically, and the pair of fixed vanes leading to that condenser assumes the polarity of the movable vane, repelling the latter. At the same time, the other fixed vanes, which are of opposite polarity, attract. Since the two forces act in the same direction, the movable vane occupies a position within the vanes oppositely charged to it, and the pointer indicates a ground on the side of its deflection. The primary plates of the condensers are connected to the line, and the secondary plates to the fixed vanes of the instrument. The use of separate condensers for charging the fixed vanes keeps all high potential currents away from the instruments and also has an advantage in that the instrument may be mounted wherever convenient without regard to the position of the line wires. The condensers may be located at or near the line wires and insulated from each other by as great a distance as may be deemed necessary.

The electrostatic ground detector shown in Fig. 2 is similar in construction to the electrostatic voltmeter common to laboratory use. The two lower quadrants are connected to ground and the two upper quadrants to the lines. The vane with its pointer is pivoted at the centre of the circle formed by the quadrants and rests normally at zero, lying across the shortest path between the positive and negative quadrants, the upper right and left. When either side of the line is grounded, the lower quadrants cease to be neutral, disturbing the balance of the system, and the needle deflects to the right or left, depending on which side the ground occurs. The moving mechanism has no electrical connection with either side of the line or with the ground, and resistances are sometimes placed in series with the instrument. A three-phase ground detector is shown in Fig. 3. This is practically a combination of three single-phase instruments symmetrically arranged and enclosed in a case. When no ground exists the three needles point to zero, and when a ground occurs on one of the lines the two adjacent needles are deflected toward the segments to which the grounded line is connected. If a ground occurs on two lines the needle between the segments connected to the grounded lines will be deflected toward the one having the lower resistance ground and the two remaining ones will be deflected toward the grounded segments.



STUDENTS' Section

Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

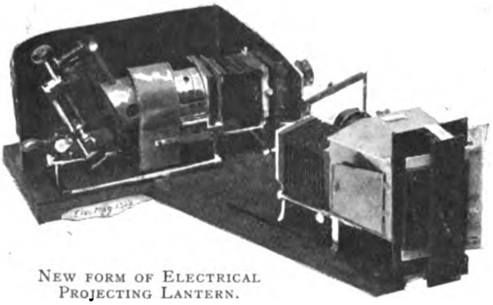
The Real Meaning of Co-operation.

At the beginning of a New Year it is customary to tender ad-advice on general conduct which at any other period would be taken as irrelevant and almost impertinent. The younger members of any institution or scheme of instruction are being made the constant butt of professorial maxims, more particularly on technical matters, so that they fail to appreciate advice which may stand them in good stead when they come to apply their special knowledge in the wider fields of commerce. More often than not this advice is not forthcoming from the daily round of work at college or class, and students enter the lists with only such ideas of commercial conduct and integrity as they have gathered from limited reading or infrequent contact with the life outside the narrow limits of their studies. Some interest will therefore attach to an admirable address delivered recently before a meeting of district managers of the Westinghouse Co., at Pittsburg, on the subject of "Useful Co-operation," which *in toto* makes excellent reading, but which can also be abstracted with equally good effect.

The lecturer was Mr. W. C. Kerr, President of Westinghouse, Church, Kerr & Co., the the world-famed builders of monster steam and gas engines. Mr. Kerr went closely, at the outset, into the meaning of co-operation, and found some difficulty in giving an exact definition of the word. He says, "From what I have seen in twenty-three years, I have a firm belief that one difficulty in obtaining true co-operation lies in the fact that we have a very imperfect idea of what we are trying to obtain. Some things are hard to define. Entomologists have tried to define the word 'insect,' but a very astute authority prefaced his writings by stating that he had found this so difficult that he would suggest the reader to catch a grasshopper, look at it for a while, and gain his own impressions regarding the main characteristics of an insect. I think the best idea of co-operation will be the impression of any one obtained through experience with true co-operation, regardless of just what form it may take. The real thing is rare, though it is frequently approximated in various degrees.

"Instead of definition, it may be more useful to apprehend some of the basic principles which underlie it. The first of these is co-operative unselfishness, the second is administrative unselfishness, and the third is personal unselfishness. With a selfish motive co-operation cannot exist. Another necessity is honesty of purpose, which involves truthfulness ; not merely the willingness to tell the truth, but the ability. Co-operation, like credit, is a fundamental principle underlying successful action in the world of peace, commerce, and war. It is practised in nature by the ants and bees, and is more or less reflected in the principle of mechanics, even to the holding together of the solar system. So, if anyone thinks co-operation is a little bit of a thing which we are more or less creating or failing to create, they are taking a very limited view of its sphere."

Mr. Kerr's remarks are of vital importance to students in that they were addressed to a meeting of salesmen, and, as a rule, no keener member of any profession exists than the man concerning himself with the marketing of a manufacturer's goods. Not all students



New form of Electrical Projecting Lantern.

will remain experts in physics, or mathematics, or any special branch of electrical work for instance, and as the demand now is for men on the commercial rather than the designing and constructive side of engineering, those having a taste for the former should bear advice of this kind in mind.

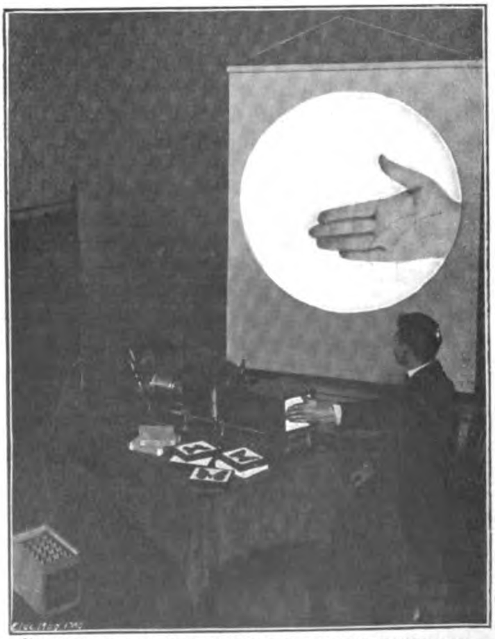
Speaking of the reward of co-operative effort, Mr. Kerr is concise and to the point: "Effectiveness gets fairly weighed and compensated by the world's scales. No man is paid for what he is going to do—he is only partially compensated for what he has done. There must be a profit in everything, and therefore no man is paid as much as he is worth. His ability to perform must be bought at one price and sold at another. If he grows his compensation will grow, and no small part of growth is the ability to rise and do things that need to be done, no matter what they are; to rise from selfishness to greatness, with competency in all the detail involved in these important advances." Again, Mr. Kerr loses sight of none of the little courtesies of co-operation: "Nothing is too small to co-operate upon. Nothing is too small to be good. No act too small to be kind and courteous. No man is able to know exactly what the result will be of anything he does. He thinks he knows, but he doesn't. The world has a way of judging what a man means by what he says, even though it doesn't size it just as he says it. Humanity is peculiarly adept at understanding people from their actions, especially their sustained and constant actions. Temporarily one may misjudge, but in the long run the old adage that 'right wins out' is more true than 'virtue is its *only* reward.'"

There is a grim humour in Mr. Kerr's reference to memory. He says: "Good memory has its advantages, but every man should be a good forgetter. A bit of reflection will show that many unsatisfactory events are never cleared up, and life is too short to apply the last analysis to everything. Don't emulate Henry Ward Beecher's dog that chased a squirrel through a knot hole in a high board fence, and stood there barking; then returned every day thereafter and barked awhile at the hole."

Concluding his address, Mr. Kerr sums the matter up with a few cogent remarks: "There is a wrong notion in the world as to the sequence of some things. You must first perform and re-perform, and prove that you can perform and keep it up before you get credit for performing. A large proportion of people in the world can't do certain things because they never tried, and many have thought they could not because they did not do very well the first time they tried. There isn't anything pertaining to the general conduct of himself in the world that a man can't do, and any man will make of himself just what his motives lead to. Consciously or unconsciously his motives make him, and his practice will follow from what he has made."

* * *

(*The subjoined articles have been submitted in response to our request, in the November and December issues, for co-operation by Students in the conduct of this Section. Up to the moment of going to press we have only*



Projecting Lantern in use for Throwing Physical Objects on the Screen, and greatly Magnifying them for Demonstration Purposes.

received these two replies, but hope we shall be given an opportunity of selecting from a greater number for our next issue. Students should remember that prizes are offered for the best work published.—Ed.)

Wireless Telegraphy.

The Isolation Problem.

By W. H. MARCHANT.

In this article I propose to put forward a suggestion regarding the isolation of wireless messages, which appears to me to be a practical solution of the problem. The accompanying diagrams, Figs. 1 and 2, represent an ordinary syntonic transmitter and a syntonic receiver. The inductance and capacity of each of the four circuits must be so adjusted that they have the same time period. This is so when the product of inductance and capacity is the same numerically for each circuit; the transmitter and receiver are then in tune. This arrangement is effective for distances of over twenty miles, but for smaller distances the receiver would respond to any radiator having a frequency anywhere approaching its own. The arrangement proposed is that by means of a clockwork motor or other device, the inductance and capacity, and therefore the time period of the transmitter, should be altered, say, ten times a minute. The receiver to which it is working would be treated in a similar manner. The changes in both instruments must be made at exactly the same time. The motors must therefore rotate at the same speed, and be started at the same time. It will be seen that, although the frequencies of the instruments are rapidly changing, at any given moment they will be the same, and, therefore, in tune. By this arrangement a large number of stations could send out signals simultaneously, and could be made to have vastly different frequencies. The signals from each transmitter would therefore only record on those receivers whose frequencies were the same as their own. It would also be possible to work several instruments on one aërial.

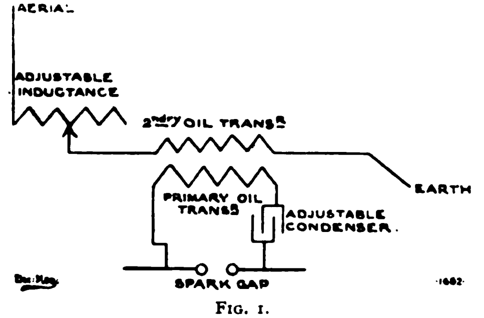


Fig. 1.

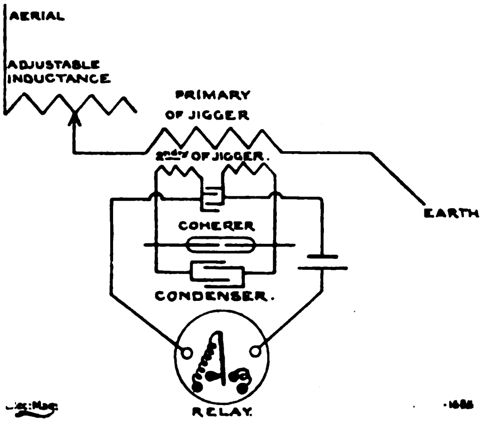


Fig. 2.

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The Effect of an Alternating Current on the Human System.

By W. DARLING.

When a person is subjected to an alternating current, certain effects are produced. These effects depend:

(1) On the strength of the current.
(2) On the shape of the wave of current.
(3) On the number of complete cycles per second.

At a frequency of 100 cycles per second an effective current of .004 ampere produces a painful shock. Swinburne estimates that an alternating current of .014 to .03 ampere is dangerous, depending, of course, on the constitution of the person who receives the shock. With an alternating current of a given strength, say .03 ampere, and a wave similar to that given by a Gramme alternator, in all probability the shock would be dangerous; but if the wave form is altered to that which is given by the Siemens machine, and the current is kept at the same strength, death will ensue.

The reason why this should be so is because the change of current strength is more gradual in the case of the Gramme machine. With the Siemens machine the change is very abrupt, owing to there being no iron in the armature of the alternator.

With a pulsating current, the more abrupt the change, either when increasing or decreasing, the more severe will be the shock.

According to M. d'Arsonval, when the frequency is gradually increased the phenomena of neuro-muscular excitation increase till from 1250 to 1500 cycles per second, from 1500 to 2500 they are stationary, and after that they decrease. Therefore an alternating current at 1500 periods per second is more injurious than the same current at 10,000 or 150 or 40 cycles per second.

M. d'Arsonval experimenting with high frequency alternating currents of from 600,000 to 700,000 cycles per second was able to light seven 155 volt lamps, arranged in parallel with each other, each lamp taking .5 ampere by the current through his body. If a current of the same strength (3.5 amperes) of ordinary frequency was applied instead it would instantly stop respiration, and would cause violent contractions in all the muscles. One explanation of this is that the distribution of an alternating current is quite different from that of a continuous current, the higher the frequency the more the current keeps to the surface of the conductor, so that with a fairly high periodicity a copper tube will be quite as good a conductor as a solid rod.

From Professor to Student.

Given a dynamo shaft with spider carrying core-plates, commutator, &c., weights and distances, including weight of shaft, being supposed known, to find the maximum deflection. The problem is fairly simple to solve graphically, but I should like a general formula for the above.

No useful purpose could possibly be served by any "general formula" as suggested by our correspondent. The graphical method of determining the bending moment is at once the simplest and the only practicable one. The problem, however, as stated by our correspondent is in any case of no practical value, for it omits the consideration of two additional very important stresses which have to be taken into account, viz., the magnetic side-pull due to eccentricity, and the torsional stress due to the driving torque when the machine is running. A full discussion of the strength and deflection of armature shafts when all these factors are taken into consideration would occupy rather more space than we can at present spare in this column, and perhaps the best advice which we could give our correspondent is to refer him to standard works on dynamos, such as S. P. Thompson's "Dynamo-Electric Machinery," or Hawkins' and Wallis' "The Dynamo," or Fischer-Hinnen's "Continuous Current Dynamos," in which the problem is fully dealt with.

I should be very glad if you would correct my obvious misconception in the following matter. The Committee of the Institution of Civil Engineers, which considered the question of the thermal efficiency of steam engines, say: "In the case of a steam engine, the heat supplied is to be calculated as the *total* heat of the steam entering the engine, less the *water* heat of the same weight of water at the temperature of the engine exhaust." In the case of a compound engine with a receiver pressure of 15lb. we should debit the H.P. cylinder with the *water* heat of so many pounds of water and credit the L.P. cylinder with the *total* heat of the same weight of steam. Where does the water come in? Engines exhaust steam, not water, and I fail to see why the steam passing an exhaust valve should be valued, as to the energy it contains, on an altogether different basis from that applying to steam passing a stop valve. On the other hand, I find that if the total heat of the exhaust steam is subtracted from the total heat of the steam supplied, the difference is not sufficient to account for the work done by the engine.

Our correspondent's main difficulty arises from his entirely overlooking the fact that any reasoning regarding the thermal efficiency of heat engines must, if it is to be sound, be confined to *cyclic processes.* The working substance, that is to say, must, at the end of the complete series of operations, be brought back to its *original state.* Now in the special case of a steam engine we are dealing with a working substance which, during the series of operations constituting a cycle, changes its state from the liquid to the gaseous form, and vice versa. We *start*, in our boiler, not with *steam*, but with *water.* The water has to be raised to boiler temperature and evaporated before it is supplied to the engine, and this involves the expenditure of a definite number of heat units. Out of this number a certain fraction is obtainable in the form of mechanical work; the rest is rejected. But the substance which finally leaves the engine —whether this be a condensing or non-condensing one—has to be reduced to its original state of *water* before it is again injected into the boiler to pass through the same cycle of operations. Even if the temperature of the air were 212° F. (or above this temperature) this would make no difference; for the exhaust steam would still have to be condensed into water at 212° F. (or a higher temperature) before we could again introduce it into our boiler. In a condensing engine, the identical substance is used over and over again; in a "non-condensing" one, the water injected into the boiler is not the identical steam which was exhausted and condensed, but the effect is obviously the same as if it were.

WIREMEN'S Section

Electric Light & Power Wiring

Artisans

Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Exit 1905.

By STUART A. CURZON.

THERE is always a kind of pathetic interest in looking at what has passed, and a casual glance through 1905 as far as electrical work is concerned only goes to show us what might have been. To what extent have we progressed, and how much nearer are we to the ultimate total sway of electricity for lighting and power purposes? It must be remembered that progress is more important to the mechanic than it is to the employer. There is always the possibility that the latter with his capital—to whatever extent it reaches—can grasp the opportunity to branch out in other directions when trade is bad. In these advanced days of limited liability companies loss of capital is spread out and is in most cases a question of savings or accumulated funds. Should failure arrive the shareholders can suffer the loss of their capital without affecting their living. But to the artisan, trade and its volume is tantamount to food or the lack of it in the larder. His capital is his ability to earn coupled with the field for his capabilities.

How has 1905 treated us in this respect? With unemployed marches and terrible tales of distress dare we say that things improved in our industry steadily throughout the year? To those of our readers who are able to gauge the amount of employment prevailing it is an admitted fact that not only could wiremen and electricians secure work more readily but received better wages. The state of employment in the electrical trade is better at the time of writing than it has been for quite a while, and it is not necessary to go beyond the large amount of important building work that has received such an impetus lately to account for some major portion of the good things vouchsafed us.

Take a casual walk down London's main thoroughfares as an example. We find beautiful theatres, imposing hotels, luxurious suites of offices and flats and important business premises rising on all sides—some completed, some well in hand, and again more being started. The City fathers notwithstanding, all these new premises are wired and fitted for electric light, many with electrical heating apparatus, and most with electric lifts. The amount of employment that these things have brought to us is wellnigh incalculable, and there is more in the air. London in particular has been inoculated with reconstruction fever, and it is well. It is a pity that we still have a few old washerwomen to direct affairs. Take Kingsway as an example. One of London's finest streets—practically a memorial for future generations of the greatest ruler our Empire has ever had. Yet feeble, flickering, failing gas lamps are the illuminant. Still washerwomen don't live for ever, and gas interests will not long control Kingsway. With this possible exception, a new street means "Wiremen wanted." By and by stately buildings will rear their heads along this beautiful street. Every one will be wired throughout. Here alone is a nice legacy from 1905.

The improvement in the quality of electrical work is unfortunately somewhat discounted by the shoddy work produced in other quarters. On the one hand we have the reliable contractor forging ahead in 1905 with steel tube work and largely dropping casing. Better and more lasting work has been his watchword. Continuous conductivity for tubing has been more fully recognised, and either screwed tubing or continuity nipples are much more in evidence.

On the other hand, the plumber-bellhanger-electrician, with side lines in tacks and candles, pursues his way merrily. The poor consumer—my word, how he consumes! A month after his premises have been wired he lifts the indiarubber doormat to switch on his lights. A gradual but rapid decay sets in, and constant tinkering results. A few 1905 jobs of this nature have been seen by the writer and duly marvelled at. What Providence there must be to watch over the jerry-contractor! Here, there, and everywhere are fire traps, and yet he goes free. Yet one day, a fire, and then—what matters? Should his business fall off in our line he smiles sweetly, puts twopence less in the plate on Sunday, and pushes candles and soap for the rest of the week.

1905 has seen too much of this gentleman. He has sprung up with increased work and thrives accordingly. But he will overdo it and the genuine electrician come by his own.

Taking it all round, however, there is no doubt that the quality of electrical installations has improved in 1905.

The past year has not brought us much that is new. There is "regenerative control" for motors for car work. In lighting we have the osmium lamp, the tantalum lamp, and the "flame" arc. Strange irony that the inventor of the former is Dr. A. von Welsbach, who produced the gas mantle. It would appear that even he has seen the end of gas lighting and turned his attention to "juice." With reference to flame arcs, when a lamp is produced to burn, say, forty hours without completely obscuring the globes with a thick deposit, then gas street lighting is all over. Willesden is about to put in sixty-six flame lamps for street lighting.

The cost of current is coming down slowly, and with the gigantic supply schemes on the tapis we can hope for considerable reductions.

Then the fiscal problem. How would this affect us? The writer is not a student of political problems, and has only casually looked at the question. But one thing has occurred to him and deserves consideration. Take electrical machinery—a tax is put on, say, German machines for the benefit of English producers. It must follow that a considerable number of German workmen will lose their employment. Trade would be good here, and as a natural consequence German out-of-works would flock here, and by unhealthy competition in the labour market tend to reduce wages to such an extent that the worker would be worse off than ever. The employers would benefit, but not the mechanic.

Well! Good-bye 1905. We cannot complain very much at what you have given us. Let us hope that 1906 will not only do better still, but that great things may occur in the trade.

The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON.

(Continued from p. 316.)

We now give an illustration (Fig. 16) showing the method of connecting two compound-wound generators in parallel. It is essential that particular attention is given to several points; notably the joining up of the ammeters. Care must be taken that the equaliser current is kept clear of these instruments.

For ordinary commercial uses this completes the types of direct current machines that the wireman may be called upon to deal with. Before proceeding to illustrate the connections and to describe the methods usually adopted in the installation of motors for tramway and crane and lift work, it will, perhaps, not be out of place if the following notes on the faults that will be met with daily on the machines previously described be carefully studied. It will often be found that faults which puzzle the wireman, and at first sight seem to him to be hopeless matters to deal with, are merely small matters if understood. The first thing is to look at the machine as though you were a doctor examining a patient for symptoms of a complaint. Starting with the D.C. generator, the most frequent faults arising after installation will be:

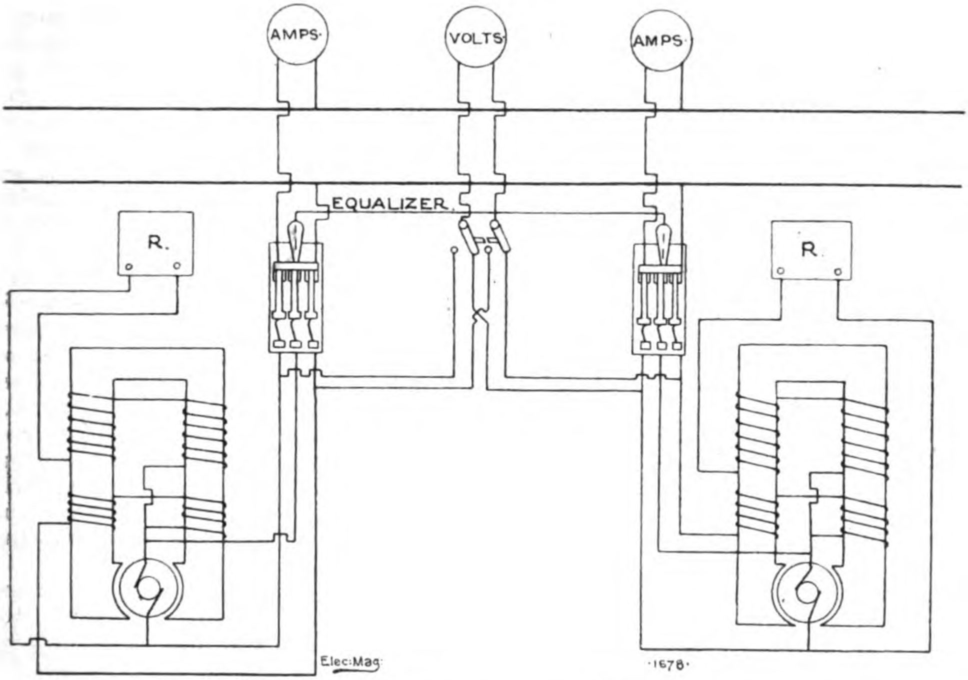


Fig. 16. Connections for two Compound wound Dynamos in parallel.

(1) The machine will not generate when run up.
(2) Bearings run hot.
(3) The commutator gets very hot in company with the brushes.
(4) The brushes spark badly.
(5) The armature gets overheated.

In the first case many causes may be found, and it is only proposed to deal with a few of the most prevalent and in no way to exhaust the list. It will often be found that the polarity has been reversed. A symptom of this will be that on running the machine up to its full speed the armature voltage will be, on a 200v. machine, anywhere from 2v. to 12v. when the exciting circuit has been broken. If it be possible to do so, reverse the direction of the running, or, failing this, reverse the field connections. In the case of multipolar machines move the brushes 90°.

Should neither of these methods be possible it will be found necessary to reverse the residual magnetism by means of a moderately strong current from an independent source. It may happen that, in connecting up, mistakes have been made, such as crossing the fields or running in the wrong direction. This should, of course, be ascertained first. Should the same symptom as described above occur when the exciting circuit is not broken, it will probably be found that there is a break in the field windings. This can readily be discovered by means of a bell and battery, and if proved the damaged coil should be rewound. A broken coil in the armature would not show any voltage at all.

It must be borne in mind that misplacement of the brushes is sometimes sufficient to cause a failure to generate, and the brushes should be moved to see that this is not the cause. A slight movement will suffice to see this, as the machine would commence to excite as the brushes were moved. The correct position can then be found.

Should it be that upon exciting a machine from a separate source it will run up to its proper voltage or, again, spark badly, it will be found that a short circuit has been set up. In the first instance it will be an armature fault. If the machine is kept excited and run, the faulty coil or coils will develop great heat and can then be traced and repaired. In the latter case the fault is on the mains, and the ordinary methods for finding a "short" should be adopted. It is

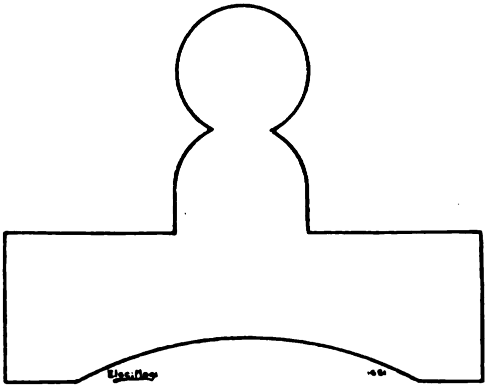


FIG. 18. EMERY PAPER HOLDER FOR COMMUTATOR POLISHING.

as well to remember that it does not follow that there is any mechanical connection between the poles ; an earth on each side may be the cause. In this connection, examine the brush holders to see that the insulation is perfect.

The second frequent fault referred to is purely a mechanical one, *i.e.*, the heating of the bearings. The first thing is to try to revolve the armature by hand. If this is difficult the bearings are either out of line or too tight. Should this not be the case, and bearings are true one with the other, it will very likely be found that the oil ring with which most bearings are fitted has stuck. See that same works freely.

Should the bearing on the pulley side alone get hot, see that the tension on the drive is not too great. It often happens that a belt is tightened up excessively to avoid slipping, when the proper remedy was to increase the size of the pulley, &c.

It must be carefully remembered that any oil is not good enough for dynamo bearings. An oil that is too thick will cause heating, or one that is devoid of proper lubricating qualities is insufficient. In either case wash the bearings out thoroughly with petrol, taking care that all the spirit has been removed before the fresh oil is put in. Use a good thin oil. It is advisable to let the bearings cool before using petrol.

Our third fault is one often occurring where machines have been put in by incompetent people. First look to the brushes. These may be either too hard or too soft. To find if the first is the cause remove some of the pressure on the brushes and observe whether the heating is less. Should this be so, replace with brushes of a better nature, and, if possible, reduce the length of the brushes between the holder and the commutator. The latter cause shows itself by the dark coating on the commutator. Clean off thoroughly, and procure harder brushes.

Our fourth difficulty is always with us, and careful observation of the numerous causes of excessive sparking will be the best instructor regarding it a wireman can have. The following will be a guide to go upon. First see that you have got the proper position for the brushes. On most machines a mark will be found, but should such not be there see that the brushes are on the commutator segments exactly halfway between the pole shoes.

Should one set of brushes only spark, and on moving the brush position such sparking be transferred to the other set, they are not equidistant. Count the segments and adjust accordingly.

When adjusting brushes on new machines it is not only unnecessary but very undesirable that they should be in line with each other. See that they are placed on the rockers so that they slightly overlap, thus assuring that the commutator will wear evenly and not have lines cut on the surface. Should this scoring have already occurred it will be advisable to at once true the commutator up.

A further cause is that the brushes are not suited to the dynamo. It often occurs that the man in charge of a machine thinks any brushes will do, and buys accordingly. It can be taken as a golden rule that the maker of the machine is the one to supply the brushes, and it will be found advisable to always send to him for supplies. Another point of failure is the substitution of carbon for copper brushes. It is not every machine which is open to be converted in this way, and the advice of the manufacturers should be taken upon the point before it is attempted.

Sparking will nearly always occur on an overload. It will sometimes be found that the dynamo attendant has got a distorted notion of the parts which should be lubricated and is giving as much attention in this direction to the commutator as he is to the bearings, and, by means of a preparation of some fearful manufacture, is endeavouring to ease the path of the brushes by oiling the commutator. Nothing whatever should be used but the most minute quantity of pure oil.

Should the sparking occur through the roughness of the commutator segments, carefully smooth down with fine glass-paper on which a drop or two of pure oil has been placed. Cut out a piece of wood to fit the curve of the commutator, as Fig. 18, and press glass-paper on firmly while the machine is rotating with the brushes off. Do not on any account use emery paper or cloth, or still further trouble will ensue.

There are many slight causes of sparking, such as bad contacts or faulty brush pressure. Too high a speed will also give rise to the same thing. It is rare that any fault on the machine itself occasions sparking without at the same time developing some other easily recognised symptom. It may be worth noticing that it will sometimes be found that mica insulation does not wear down at the same rate as the copper segments. The remedy for this is obvious. Again see that the connections between the coils and the commutator bars are all good.

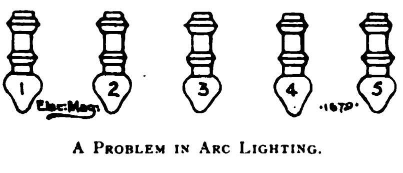
(*To be continued.*)

Notes.

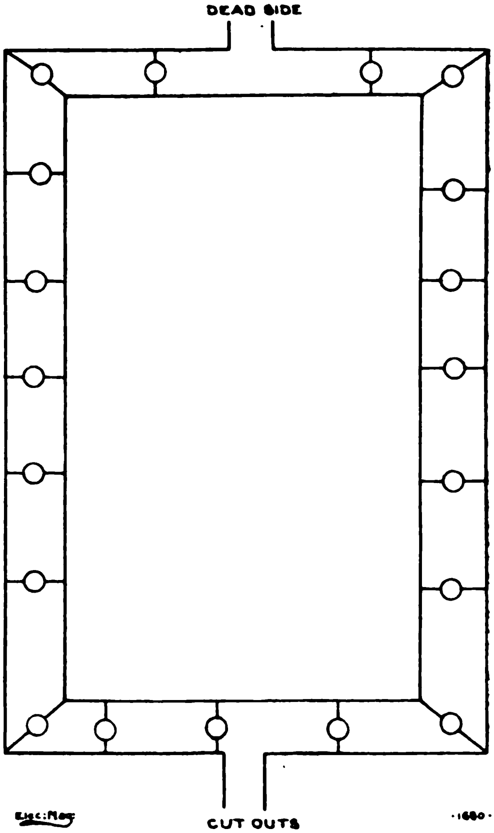
HEREWITH we give the best answer to the problem on wiring published in November issue. The advantage gained by using multiple series is that should one lamp fail the only result is to increase the voltage on the lamps in the same series, but with a single series under the same conditions two lamps would be out. There is a considerable saving in wire over most other solutions.

* * *

This month's problem is also taken from the *American Electrician* and will be found of considerable interest. Five series arc lamps are to be connected to a 105v. circuit in such a way that three will be burning at one time, the centre lamp being connected to either group. It is taken that the lamps require 35 volts each.



A PROBLEM IN ARC LIGHTING.



SOLUTION TO PROBLEM IN NOVEMBER ISSUE.

On the same day that Boswell was killed at Hammersmith (see November issue) an inquest was held at Cheltenham with reference to the death of John Moore, who was scalded while engaged in cleaning a purifier to a Babcock boiler at the Electric Light works. The evidence was to the effect that Moore sent a mate for some packing and on the latter's return he found the deceased scalded. The assumption was that Moore had turned on the cocks and the stoker turned on steam.

The jury added a rider to their verdict that the accident was in a great measure due to the lack of rules and regulations, and expressed an opinion that the workmen should take more care. Isn't this playing it a bit low down? Should not the engineer be the one to frame rules and regulations and "take more care"?

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Power.

Articles.

Hydro-Electric Power under the Highest Head in New England.	*Elec. Wld. & Engr.* 2/12/05.
*Long Distance Power Transmission by Direct Current. F. J. Sprague.	*Elec. Wld. & Engr.* 30/12/05.
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*The Transmission Circuit. C. F. Scott.	*Elec. Journal, Dec.*/05.

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*Technical Education of the Twentieth Century. J. C. Wait.	*Clarkson Tech. Sch., N.Y.* 30/11/05.
*Realization of Ideals in Industrial Engineering. H. F. J. Porter.	*Amer. Soc. Mech. Eng.* 3/12/05.
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* * *

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(*Books Reviewed below will be forwarded at once on receipt of published price.*)

"Daily Mail Year Book."

Edited by P. L. Parker. Amalgamated Press, Ltd., London, E.C. Price 1s. 6d.

It is simply impossible to "review" a book such as this. To call it a *multum in parvo* is not to describe it. A mine of information is not strictly to the point. We must bemoan the deficiencies of language, like the victorious Liberals, and content ourselves by saying that the "Daily Mail Year Book" is a marvel for the money; should be on every office desk, and in every domestic library; and that in its sixth year of issue it is like Charley's Aunt, "still running." Unlike most works of the kind it is blessed with a valuable and useful index.

"Hazell's Annual. 1906."

Edited by W. A. Palmer, B.A. London: Hazell, Watson and Viney, Ltd., Long Acre, W.C. Price 3s. 6d.

This vigorous and hardy specimen of book annuals celebrates its majority with the 1906 issue, and in every way justifies its claim to the privileges usually conferred upon manhood. The work covers an enormous field, and in an engineer's office will be generally useful, but much more should it be valuable for its excellent articles on such subjects as Canals, Education, Engineering, The Fiscal Question, and the Housing of the Working Classes. The review of Electrical Progress is well put together, and may be constantly referred to during the coming year. The scheme of classification is well thought out and tends to avoid unnecessary cross searching or indexing.

"Ueber die Oxydation des Stickstoffes in der Hochspannungsflamme."

(On the Oxidation of Nitrogen in the High-voltage Arc.) By J. Brode, Halle-a-S.: W. Knapp. 1905. Price M.2.50.

This important and highly interesting monograph of 63 pages should be carefully studied by all who are interested in the problem of the manufacture of nitrogen compounds—a problem which, in view of the rapid exhaustion of the Chili saltpetre beds, is yearly assuming more and more economical importance. The interest aroused by the formation of the Atmospheric Product Company in the United States will be fresh in the memory of many; unfortunately, the great hopes entertained by the promoters of that company were not realised, and the company had to suspend operations in the summer of 1904. The author of the present monograph gives a sketch of the theory of the formation of nitrogen oxides, of the more important attempts to produce such oxides on a commercial scale, of the scientific investigations carried out in connection with this subject—including his own researches—and of the present economic status of the problem.

"The application of Electric Motors to Machine Driving."

By A. Stewart, A.M.I.E.E. London: S. Rentell and Co., Ltd., Maiden Lane, W.C. Price 2s.

The title of this work is a misnomer, and that is the only fault we have to find with it. We should have preferred to see some such terse sentence as "The Case for the Electromotor" instead of the legend which adorns the cover and title page. The work is an admirable piece of special pleading on behalf of the electromotor as compared with other power agents for the driving of industrial machinery. There is no time lost in the elaborate treatment of first principles, the author getting very quickly down to his subject. After a concise statement of what the electromotor is and of the devices employed to start it, the reader finds himself up against a number of cogent reasons regarding the economies of electricity. The failure of the gas engine as a commercial competitor of the electromotor is made unmistakably clear, and the author's arguments may well be drawn upon by canvassers on electricity supply concerns for a motive power load. Subsequent chapters of the book deal with electric power in steel works, shipbuilding and engineering works, printing establishments, textile factories, &c., while electric cranes and lifts and miscellaneous applications also come in for treatment. The last chapter deals with electricity tariffs and the cost of power at varying rates. A very lucid explanation is given of the maximum demand system, this being materially assisted by a diagram showing at a glance the reduction of charges to the long hour consumer. The price of the work should ensure for it a very wide sale, and in addition to being valuable to the development department of any electricity works, central station engineers might do worse than distribute a number of copies among likely customers in their districts.

Glover's Hardy Annual.—W. T. Glover and Co., Ltd., Trafford Park, Manchester. When Glover's Almanac fails to turn up at the year's end, electrical engineering will be dead. It is now nothing short of an institution, and we simply could not get on without it. The standard set by its predecessors is well maintained in the current copy; in fact, we think the "Glover's Selections" are better than ever. A wider field of journalism has been tapped, and the "loose ends" are worth taking hold. We cannot guarantee compensation for effects from shock, though someone may get laid out with electrolysis of the diatrine—beg pardon, diaphragm. For the benefit of our Antipodean, Equatorial, and Arctic readers, we shall quote from the calendar as occasion demands, making, of course, every fitting acknowledgment.

A Year's Review of Electrical Manufacturing Progress.

THE various world centres of activity in electrical manufacture have, during the past year, been more continuously productive than was the case in the previous twelve months. From all quarters the record of electrical trade is an encouraging one and gives great hope of considerable improvement in the year now opened. New fields of application are constantly being broached, but there yet remains much to be done in industrial centres until recently under the entire dominance of steam in the matter of power, and of gas in respect to lighting. Electrical Engineers need seek no other worlds to conquer, nor need their ambitions range beyond the borders of their own lands, as vast labours must yet be expended before the demand for electrical plant and apparatus ceases to promote trade within the limits of Empire or Continent.

The United Kingdom.—British electrical trade slowly recovered from the slump of the fall of 1905, and up to the opening of the Tramways Exhibition was gradually making up lost ground. At the close of that display a decided upward tendency was noticeable to the opening of the Olympia Exhibition, and after the conclusion of that brilliant Exposition of the lighter electrical arts a sustained advance in that branch of the industry can be recorded. For some considerable time, at any rate until railway electrification is consistently taken up—this section of electrical manufacture will witness the greatest activity because of the increased demand which will be created by the power companies and electricity supply undertakings. Expansion in this quarter will also reflect favourably upon the heavier branches of manufacture, as plant extensions will need to be met and also obsolete machinery will be replaced. In effect the Olympia Exhibition has given a renewed impetus to electricity supply, whether furnished by bulk power concerns, local authorities, or small companies, and the manufacturing interests represented in this province are feeling and will feel the benefit. Despite the prospects of cheap power in industrial and mining districts, several large concerns have installed extensive private plants during the year, and there seems little or no prospect of a limit to this kind of installation. They constitute, however, considerable business for makers whose standards in dynamos and engines do not extend in the higher range of outputs. The development of suction gas plants has boosted trade prospects in country house plants, and the crude oil engine also has been given extensive application in this field. Colonial trade with the home manufacture of electrical apparatus is still brisk, as is evidenced by the large orders executed during the year, notably in the matter of tramways. South Africa remains an excellent market for British electrical goods, and already a great proportion of the apparatus in use there has come from the home makers. The superiority of British goods seems everywhere to meet with appreciation, but that alone cannot find them markets, as the zeal of Germans and Americans clearly proves.

Foreign Countries.—Of the great industrial countries, the United States heads the list for electrical activity in its every aspect. From heavy dynamo electric machinery to instruments and telephones, throughout the entire range, there is an almost amazing consistency of output, and the capacity to manufacture is in no way subordinated by ability to sell either at home or abroad. The whole American continent presents, however, a vast field for enterprise and exploitation, so that the ultra-virile state of American electrical affairs need occasion little astonishment. Americans are, however, not contented to conquer the broad expanses and desert places of their own lands. They compete with all comers in Japan, China, Australia, New Zealand, and South Africa. Installations of American plant are to be found in all these countries, clearly proving that distance is no obstacle to enterprise. British manufacturers should be encouraged by these tactics to develop foreign trade in unprotected countries, as transport presents the least difficulty, and only organised effort is required to feel the pulse of the foreign market and regulate prices accordingly. The time to get trade is the present. Soon our neighbours will be erecting their own factories, and business will gradually drift to local makers with whom we could not hope to compete. Italy, Japan, China, Australia, and Canada all present examples of this latter movement, and but a few years will elapse before the way into their markets for electrical goods will be finally closed to outsiders.

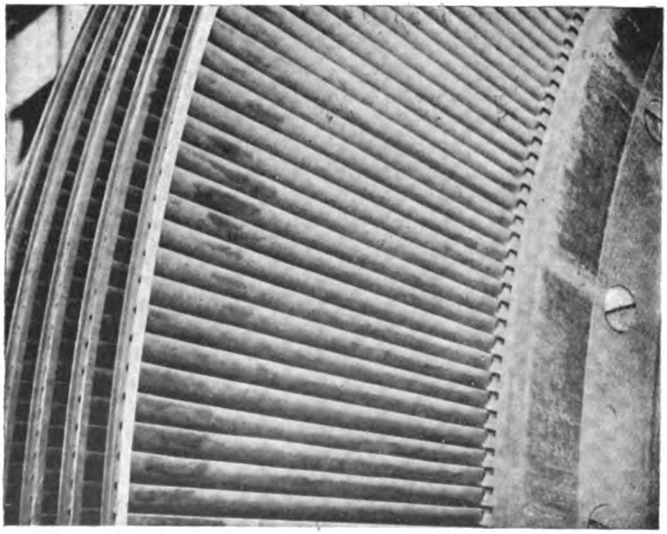
Improvements in Steam Turbine Construction.

THE steam turbine is now regarded as an institution in all modern electricity stations, so that little notice is now taken of the installation of this form of prime mover in power houses. Considerable interest, however, attaches to improvements in the mechanical details of these machines, especially those relating to the blade construction. The blades, both moving and fixed, are the vitals of the machine, and early types left much to be desired in the matter of their fixing and stability during running. Stripping was a not uncommon occurrence, and in some cases blades have been known to leave their seating and do much damage to their neighbours before the machine could be stopped. Experience has brought out all these defects, and while they have been repaired in the early machines, in the latest types steps are taken to prevent their appearance. The Allis-Chalmers construction, for instance, embodies a number of new features which are claimed by the builders to be distinct improvements.

The chief distinguishing feature of this construction is the blading, which, while it is of the Parsons reaction type as regards the principle of operation, differs in mechanical construction in a number of essential details. The roots of the blades are formed in dovetail shape by special machinery, and are inserted in slots cut in foundation or base rings, these slots being formed by special machine tools to exactly conform to the shapes of the blade roots. The foundation rings are of dovetail shape in cross section, and are inserted in dovetailed grooves cut in the turbine cylinder and spindle respectively, in which they are firmly held by key pieces, after the manner of the well-known "Lewis bolt." To further ensure integrity of the construction, the key pieces or rings, after being driven into place, are upset into undercut grooves.

Another noticeable feature of the blading is the method of reinforcing and protecting the tips of the blades. In forming the blades a shouldered projection is left at the tip. This is inserted in a slot punched in a shroud ring. The slots are punched in such a way as to produce accurate spacing and at the same time form the slots so that they will give the proper angles to the blades independent of the slots in the base ring. After the blade tips are inserted in the slots in the shroud rings they are riveted over by special pneumatic machinery.

The shroud rings are of channel shape, with outwardly projecting flanges which, after assembly in the turbine, are turned and bored to give the necessary working clearance. The flanges of the channels are made so thin that, although amply sufficient for stiffness, the shroud ring does not have the disadvantage of a solid shroud which acquires a dangerous temperature by friction in case of an accidental contact of the rotating and stationary parts. It is claimed for this construction that the blades are stiffened against the effect of vibration in a much more substantial manner than by any other means thus far employed, while the use of a protecting shroud ring enables the working clearance to be made smaller than in the case of naked blade tips, without danger in case of accidental contact, thus reducing the leakage loss to a minimum ; the leakage past the blade tips being the principal source of


THE ROTOR BLADES IN POSITION ON SHAFT OF ALLIS-CHALMERS STEAM TURBINE.

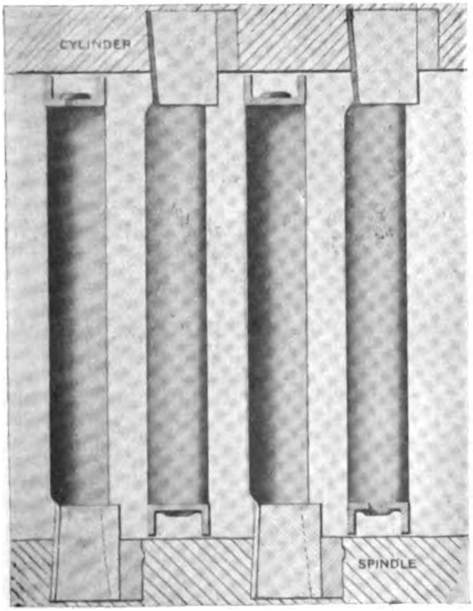
loss in the steam turbine. As to the safety from damage in case of accidental contact, it is claimed that this has been proved by experiment with actual blading, by throwing the bearings out of centre so as to produce contact, without detrimental results.

By the method of construction described the entire blading is produced by machinery, thus eliminating the personal equation which enters into blading done by hand work, which depends upon the skill of the individual workmen. Besides ensuring that every blade is securely fastened, all blades are necessarily set at exactly the designed angle and pitch; the openings between blades, upon which in great part the economical performance depends, being absolutely uniform. The blading is made up in half rings in the blading shop, and is carefully inspected before being inserted in the turbine.

The most noticeable feature of the turbo-generator is the substantial design of the revolving field, providing great strength and at the same time giving the thorough ventilation which is essential. Particular attention has been paid to the insulation, as may be inferred from the fact that the armature was subjected to an alternating current insulation test of 10,000 volts for the period of fifteen minutes.

Field Rotor of Allis-Chalmers Turbo-Generator.
The complete machine is illustrated on p. 13 of this issue.

The Allis-Chalmers Company in entering the steam turbine field effected an alliance with the Turbine Advisory Syndicate of England, thereby securing the co-operation of the firms therein interested, including Messrs. Willans and Robinson, Yarrow and Company, and the Neptune Shipbuilding Works. The unit described was built for the Allis-Chalmers Company by Messrs. Willans and Robinson, to whom a number of turbine contracts were sub-let by the Allis-Chalmers Company before the latter had perfected the installation of their special machinery for turbine manufacture. An agreement has more recently been effected with Hon. Charles A. Parsons, C.B., for interchange of data, thereby giving to the company the benefit of the vast experience of the original inventor of this type of turbine, and to whose engineering ability and indomitable energy the evolution and present state of perfection of the successful steam turbine are principally due.



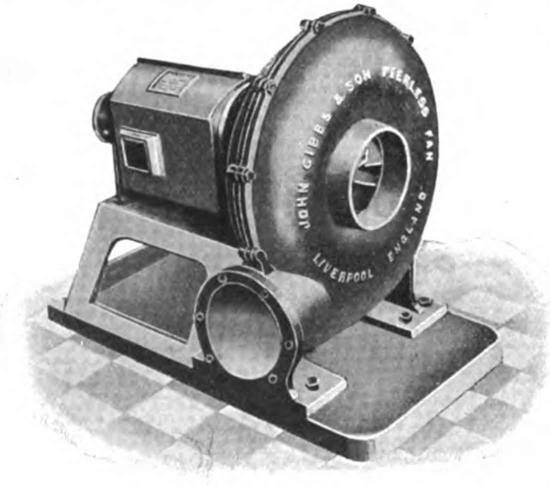
Detail of Blades as Fixed to Shaft and Cylinder.

Fans and Blowers.

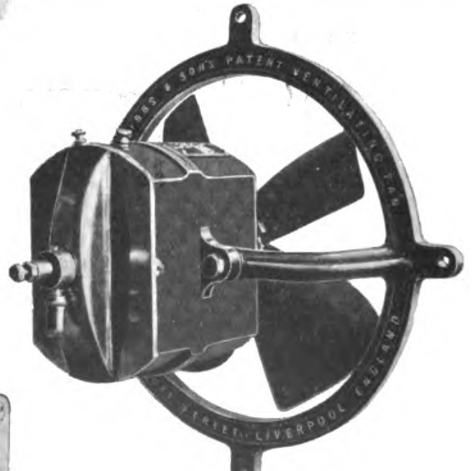
Messrs. John Gibbs & Sons.

Reviewing the electrical progress of Messrs. John Gibbs & Sons for the past year, the most noticeable feature is the adaptation of their motors to the driving of their now well-known "Peerless" blowing and exhausting fans. With these most favourable results have been obtained direct coupled, the latest departure being in connection with their "Peerless" dust separator, by which the dust is automatically separated from the air, pure air passing out of the top of the apparatus, while the dust falls to a bin in the bottom of the separator and can be disposed of at will. The motor driving the blower is controlled by a patent interlocking double-pole quick break starting and regulating switch which has recently been fitted with an overload release in addition to a no-voltage release. These precautions safeguard the motor under all conditions of load, and render the switch as perfect as is humanly possible for preventing damage to the motor. Messrs. John Gibbs & Sons have also recently completed an order for the British Admiralty for their patent fans with improved type water-tight cases, the joints of the case being made absolutely waterproof, and a gland and sprayer fitted at front end of motor to prevent either oil or water getting into the motor case. In addition to certain minor improvements in the manufacture of fan driving motors tending to furnish greater durability, a direct driven electrical "Peerless" blowing fan has been introduced, with the evidence of the efficiency of which, as reported in various testimonials from customers, the company states it has every reason to be gratified. In connection with the above there is also a dust separator which is in use with satisfactory results at the present time, entirely dispensing with the nuisance formerly caused by dust being blown out upon the roofs of neighbouring buildings, choking gutters, &c. With the aid of this apparatus this trouble has now become a thing of the past.

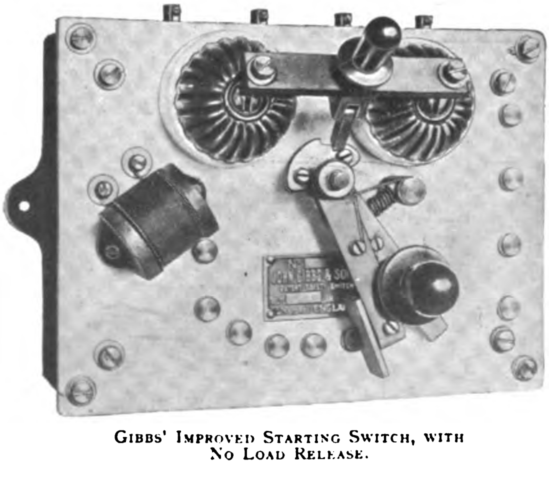
Gibbs' Ventilating Blower.



Gibbs' Peerless Blower.



Gibbs' Ventilating Fan.



Gibbs' Improved Starting Switch, with No Load Release.

Dynamo and Motor Manufacture.

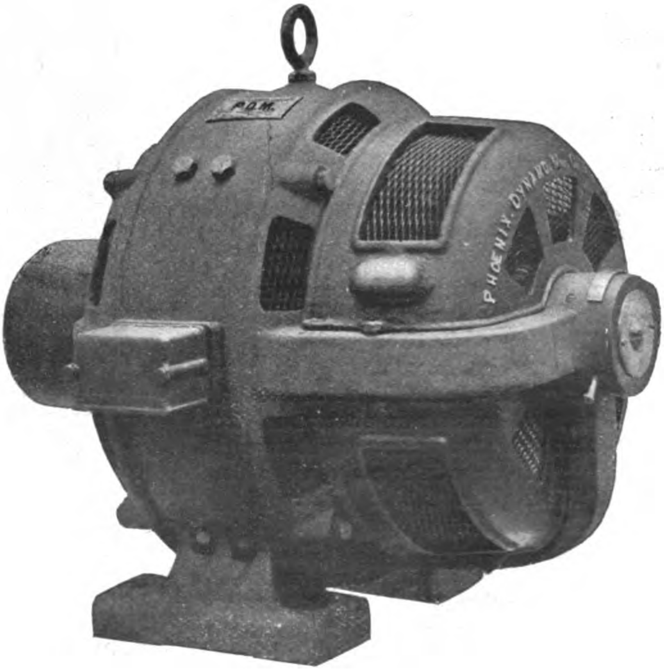
Phœnix Dynamo Manufacturing Co., Ltd.

THE Phœnix Dynamo Manufacturing Co., Ltd., of Thornbury Works, Bradford, report that their trade during 1905 has been a constantly increasing one, both in the matter of turnover and also in machines of larger sizes. Among other contracts that they have carried out during the present year have been one for the Corporation of Sunderland for some 3000b.h.p. of motor generators running on a three-phase, 5000 volt circuit, transforming the current for the lighting and power supply, these machines being in sets having an output of 300kw. each. This is a similar scheme to that which the Bradford Corporation are at present putting in; for the Corporation of Gloucester they have just finished an 840kw. set, coupled to a high-speed engine; for the Corporation of Keighley a 300kw. set, and for the Cleckheaton Urban District Council a 350kw. set, also traction generators for the Burton-on-Trent and other stations.

For the Deptford Borough Council they have installed complete sets with high-speed engines, and for the Marylebone Borough Council they have installed some 700b.h.p. of motors for working auxiliary apparatus in that station. For several local mills they have installed plant, notable among which is a complete three-phase plant consisting of high-speed engine and generator and motor for Messrs. W. and M. Whitehead, Ltd., Laisterdyke. Generators and motors for colliery work they have also been busy with especially in connection with three-phase plant.

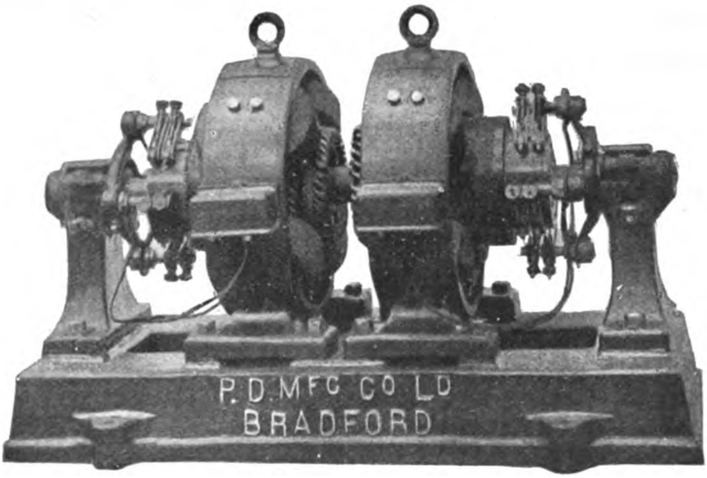
Among other contracts they have in hand at the present moment is a traction dynamo for the Tynemouth Corporation, four large motors for the Johannesburg Corporation, three 150kw. generators for the Great Western Railway Co., together with motors, &c. During the year the Company have perfected and placed on the market a complete series of machines built under their "Phœnix-Pohl" Patents, by which means they have entirely succeeded in suppressing sparking in direct-current machines, and by their improvement in ventilation they have very considerably increased the output for a given weight of material. The result is that the Phœnix Dynamo Manufacturing Co., Ltd., now stands in the very front rank for high-class dynamos having very heavy overload capacity coupled with high efficiencies.

A further speciality which the Company has placed upon the market, of which they have sold large numbers, is their Phœnix electric sensitive drill, which have been supplied to the British and foreign Governments, &c. They start the year with a large volume of work, including some of the above-named contracts, and, in addition, contracts for the



STANDARD P.D.M. VENTILATED ENCLOSED MOTOR.

West Riding County Council for steam dynamos, and for machinery for the Japanese Government, and in addition a large three-phase plant for a colliery in Nottinghamshire. The works at Bradford have been very busy during the past year, and the outlook for the next twelve months is very promising.

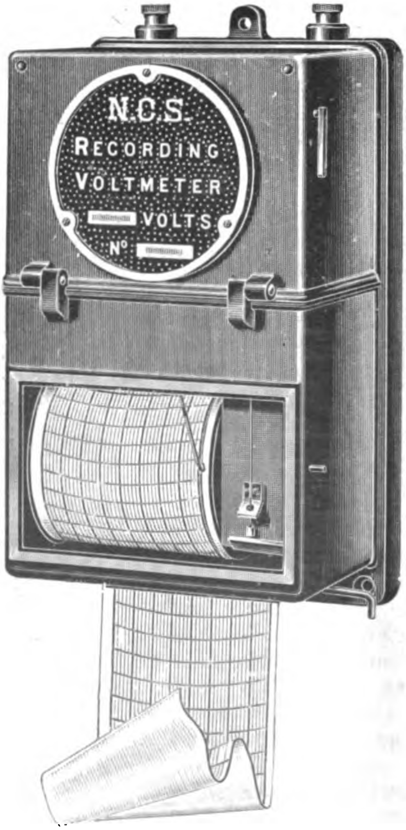


Standard P.D.M. Balancer Set.

Instrument Manufacturing Progress.

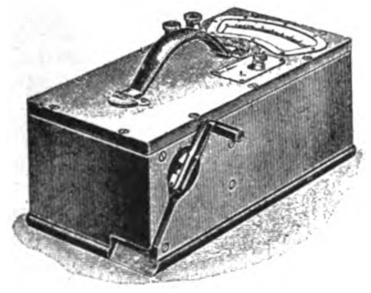
Nalder Bros. & Thompson, Ltd.

Electrical Engineering would make very poor showing but for good instruments. These form an indispensable link in the chain of electrical affairs, which needs to be strengthened at every point. In this respect the improvements introduced by Messrs. Nalder Bros. & Thompson, Ltd., 34, Queen Street, E.C., are worthy of record. The use of recording instruments has increased considerably of late years, and advances in manufacture have contributed mainly to this movement. The N.C.S. continuous record type introduced during the year constitutes an advance in that the slip is ruled off constantly and the need for frequent renewals is dispensed with. Another type of instrument brought out during the year is the N.C.S. insulation testing set, known as "The Ohmer." It comprises a generator and electrostatic ohmmeter, combined in one case, and is only 13¾lbs. weight. The instrument is indifferent to all external fields and is lighter than any other pattern on the market. Among switchboard instruments we may mention the type O.-K. dead-beat soft-iron instruments, in enamelled iron cases, for alternate and direct currents. The line of fault-testing instruments for mine use is also interesting. It includes moving coil patterns for direct currents and static types for alternate currents. A switch

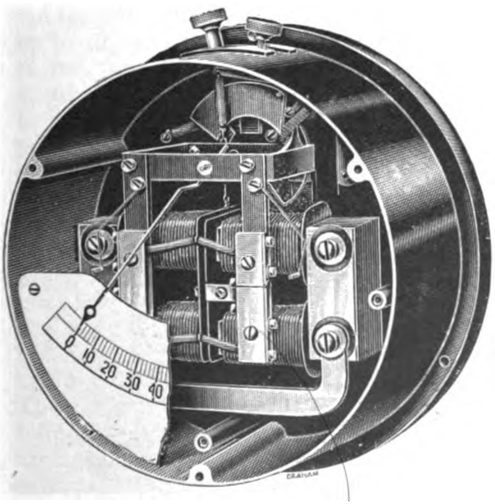


N.C.S. Continuous Recording Voltmeter.

is included in the instrument case by which the leakage on either main can be obtained. Normally this switch is in the central position, with both leads disconnected. The N.C.S. indicating wattmeter (Drysdale's Patent) is another novelty which should become general for a.c. switchboard use. It operates on an improved principle which requires no correction for self-induction and gives accurate reading on low-power factors. The movement is enclosed in substantial iron case and a clear open scale is provided. Messrs. Nalder Bros. must be congratulated on the excellent standard of their instruments and on the successful efforts they have made during the year to introduce much needed improvements.



THE "OHMER" TESTING SET.
(Nalder Bros. and Thompson.)



N.C.S. WATTMETER.
(Drysdale's Patent.)

Electric Traction Enterprise.

Mountain & Gibson, Limited.

MOUNTAIN & GIBSON, LTD., of Elton Fold Works, Bury, Lancashire, are successors to the McGuire Manufacturing Co., Ltd., whose business they purchased some twelve months ago. Their business is that of electric railway and tramway engineers, and they make a speciality of the manufacture of trucks or under-carriages of all descriptions for electric railway and tramway rolling stock. They also manufacture electric locomotives, electrically-driven sweeping, sprinkling and watering cars for use on tramway and light railway systems, as well as trolley poles, lifeguards, special brakes, and other accessories. Since the business was taken over by the present proprietors it has been largely developed, and a number of important specialities have been added to their manufactures. In addition, their designs have been considerably modified, and many important improvements are embodied in the work now turned out. This is more particularly noticeable in the trucks or under-carriages.

The class of workmanship which is being put into the trucks at present is superior to what has hitherto been done, and all details have been very carefully considered with a view to meeting the up-to-date requirements of engineers and others responsible for the running of electric tramways. The works have been very fully employed since the start, and at the present time the volume of business in hand is so great that although a young firm considerable extensions to the premises and plant are being made.

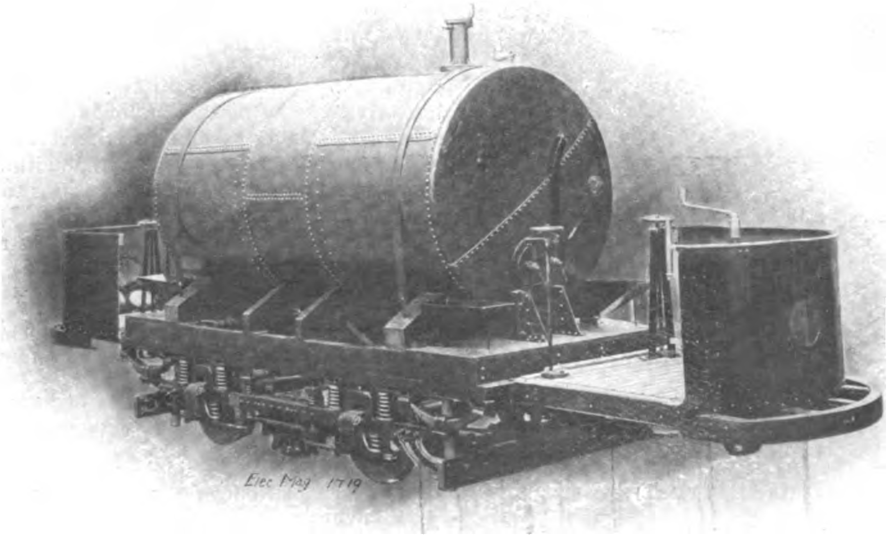
Among the very important contracts either executed or in hand are the following:—

Glasgow Corporation, 100 single trucks.
L.C.C., 200 pairs of maximum traction trucks.
West Ham Corporation, 34 single trucks, with 34 sets of trolley poles and lifeguards.
Erith U.D.C., 14 single trucks with 14 sets of trolley poles and lifeguards.
Stalybridge Joint Tramways, 15 single trucks.
Musselburgh Tramways, four single trucks.
Lancaster Corporation, two single trucks.
Bury Corporation, six single trucks.

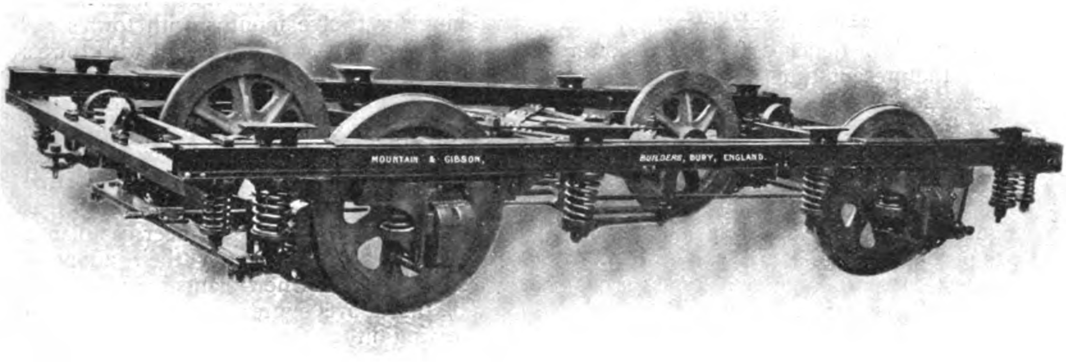
Durban Corporation, 18 radial trucks (three repetition orders).
Derby Corporation, six radials, also radials for L.C.C., Huddersfield, Dundee, etc.
Belfast Corporation, four electrically-driven sweeping, watering, and sprinkling cars.
West Ham Corporation, one electrically-driven compressed air watering and sweeping car.
L.C.C., four electrically-driven water cars.
Stalybridge Joint Tramways, one watering and salt distributing car.
Dublin Corporation, 54 refuse wagons.

To cope with the orders received, the company have installed a considerable quantity of new machinery with special appliances and apparatus to deal with their particular class of work, their efforts in all directions being centred upon the production of a high-class mechanically constructed truck or under-carriage, with all parts interchangeable, and with details so made as to reduce the cost of renewals to a minimum.

The illustration shows one of four electrically-driven water cars which Messrs. Mountain and Gibson have built for the London County Council. The car is shown with the superstructure or car-body removed, generally it consists of a substantial under-frame upon which is mounted a circular water tank having a capacity of 1,800 gallons. This is carried by strong bearers firmly attached to the under-frame, and mounted upon it and covering the tank entirely is a superstructure or car-body constructed on the lines and as far as possible uniform with the appearance of an ordinary tramcar having sliding doors at either end. To each end of the superstructure is attached a platform identical with that of an ordinary tramcar. The whole is mounted upon a single four-wheel tramway truck of the Brill 21E pattern (built by Mountain and Gibson to be interchangeable with other trucks already in service on the L.C.C. system). This truck is fitted with improved hand brake gear operated from the platforms; it is also fitted with the L.C.C. special pattern of plough carrier to suit the underground conduit system. It is further fitted on either side with a track grinding apparatus which is also operated from the platforms. From the water tank are run connections to rail flushing pipes, four of which are provided, one for each wheel. Upon the top of the water tank and projecting through the roof



Standard Truck and Water-car built by Messrs. Mountain & Gibson, Ltd.



THE M.-G. FOUR-WHEEL RADIAL TRUCK FOR ELECTRIC TRAMCARS.

of the superstructure is a filling pipe with cover, and a valve is also provided for the attachment of a compressed air pipe. The car is so built that it can be worked by means of compressed air if required. The whole design is novel and is built to meet the special requirements of the L.C.C.

The "M.G." four-wheel radial electric tramway truck is built either for use as a motor or a trailer truck, and can be constructed for any usual track gauge from 3ft. 6in. up to 5ft., and with a wheel base 7ft. 6in. up to 10ft. 6in., as required to suit the circumstances of the case. The truck is designed to run easily on sharp curves with the least possible friction and wear on the wheel tyres, the wheels and axles being allowed to accommodate themselves to the curves. It comprises an intermediate frame of steel channels with an arrangement of centre stiffeners and braces to which are fitted king pins, forming the pivotal points from which two sub-trucks radiate. These sub-trucks are independent of the intermediate framing excepting where attached to the king pin. The weight of the car-body is taken by the intermediate frame, which is supported by an arrangement of rollers mounted upon the sub-trucks working in separate oil baths, the underside of the intermediate frames being fitted with hardened steel rub plates working upon the rollers. The framing of the sub-trucks is of forged steel fitted with steel horn blocks, within which are fitted the axle boxes which are of the usual type made dust-proof. The car-body is supported by eight spiral springs of special design placed beneath the intermediate frame, the supports attached to the car body and resting upon the springs working in guides; these guides take any end thrust there may be upon either the car-body or truck. Additional springs are fitted at either end of the frame to prevent oscillation. The journal box springs are placed outside the horn blocks and rest upon wings extending from and cast in one with the journal box. The sub-trucks are provided with buffer bars at the outer ends working between springs to ensure the sub-trucks regaining their normal position after passing round a curve. The truck is fitted with steel-tyred wheels 31¾in. diameter on tread, mounted upon steel axles of special quality, 4in. diameter in body. The wheels are placed on the axles to the required length by hydraulic pressure. The brake gear is of the equalising bar type with a brake block working upon each wheel. It is operated through a central floating lever supported by brackets hung from the centre of the truck, and is so arranged that it radiates along with the sub-trucks, ensuring a proper bearing upon all wheels, even though travelling round curves.

Don't Make

For CUSTOMERS by circuitous routes - - - - -

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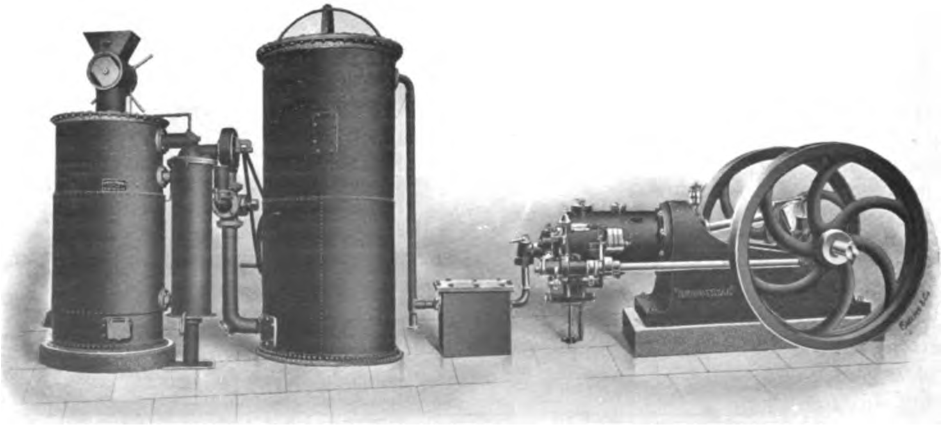
Cheap Power.

The Industrial Engineering Co.

THERE is a demand for cheap power at the present time, and where electrical energy is not readily available, other sources must be drawn upon for power. The present tendency in these cases is towards the use of gas plants. The Industrial Engineering Co., 12, Exchange Street, Manchester, have designed and are now manufacturing suction gas producers of all sizes, which will work in connection with any modern type gas engine. These plants, when using anthracite coal, will supply a 10h.p. gas engine with sufficient gas to drive it at full load for one hour, for the low cost of one penny; and larger-size engines will cost pro rata.

Plants of this class are specially adapted for places where there is not a supply of town's gas, consequently they may be used exclusively for agricultural working, electric lighting of houses, pumping, and all general purposes. Their application is almost unlimited. Since a modern gas engine will consume 200 cubic feet of town's gas for each 10b.h.p. generated per hour, and assuming the gas is metered at two shillings per 1000ft., the cost works out at 5½d. for the 10h.p. This figure, compared with the above sum of one penny, is quite out of proportion to the work done, and the use of the suction plant would show an enormous saving in twelve months' time. For example, the following figures are taken from actual working for twelve months, with town's gas and producer gas. The gas bill with town's gas was £150 per annum, and with suction gas, for exactly the same work, was only two shillings per day, or equal to £30 per annum. This is economy par excellence, and should convince users of power of the advisability of altering their existing gas supply, and substituting producer gas plants. They should also consider their adoption when extensions or new plants are projected. From the above figures it will be seen that the saving in one to two years will much more than repay the cost of the producer plant.

The plants are compact, as will be seen from the illustration below, and require very little attention. They can be started up in a few minutes, and every two or three hours only require the addition of fuel. There are no complicated moving parts in the plants, and they can be tended by unskilled labour. This latter feature especially fits them for the driving of dynamos in country houses, as the electrical part of the installation is quite simple to look after, and it is the engine portion which has hitherto required skilled attention. With the exception of replenishing with fuel every few hours, the plant may well be left to itself, as the lubrication is almost automatic.



COMPLETE SUCTION GAS PLANT AND GAS ENGINE BUILT BY THE INDUSTRIAL ENGINEERING CO.

Plants of this type bid fair to supplant the steam engine in isolated districts where coal or other fuel is relied upon for power.

Recording Instruments.

J. H. Holmes & Co.

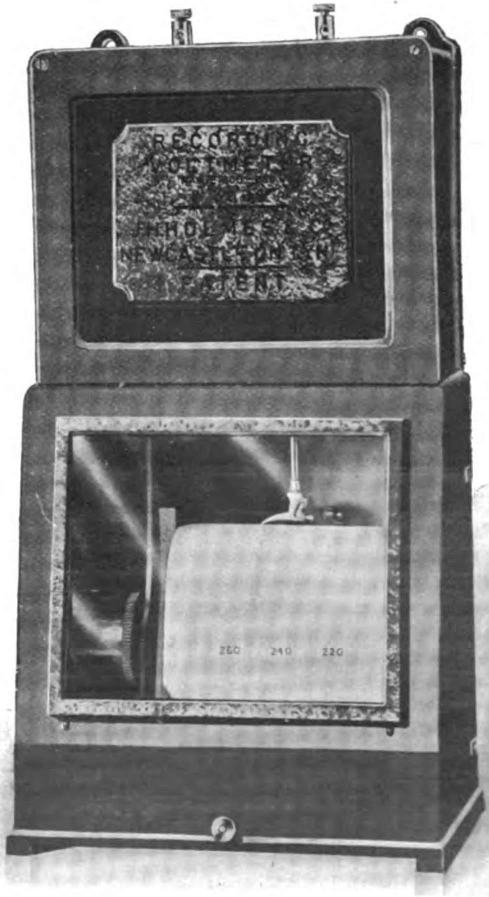
We have previously briefly alluded to these instruments, and as they possess several features of novelty which distinguish them from the ordinary type of recorder at present in general use, a few further details will be of interest. Two of the chief difficulties with inking recorders—that of driving a continuous band of paper, and keeping up a supply of ink for a lengthened period without requiring constant attention—have been overcome in a very successful manner; the former by the use of a serrated driving wheel acting on the centre of the paper band, and the latter by a special form of pen capable of carrying a large supply of ink, and moving across the paper in a straight line instead of describing an arc of a circle. The paper roll is re-wound on a spool after it has passed beneath the pen, and it has, therefore, no tendency to become wedged or creased up; it will run safely without any attention for a period of at least fourteen days.

The recorders are made up in two forms:—switchboard type in cast-iron case, and portable type in mahogany case, with carrying handle and levelling screws.

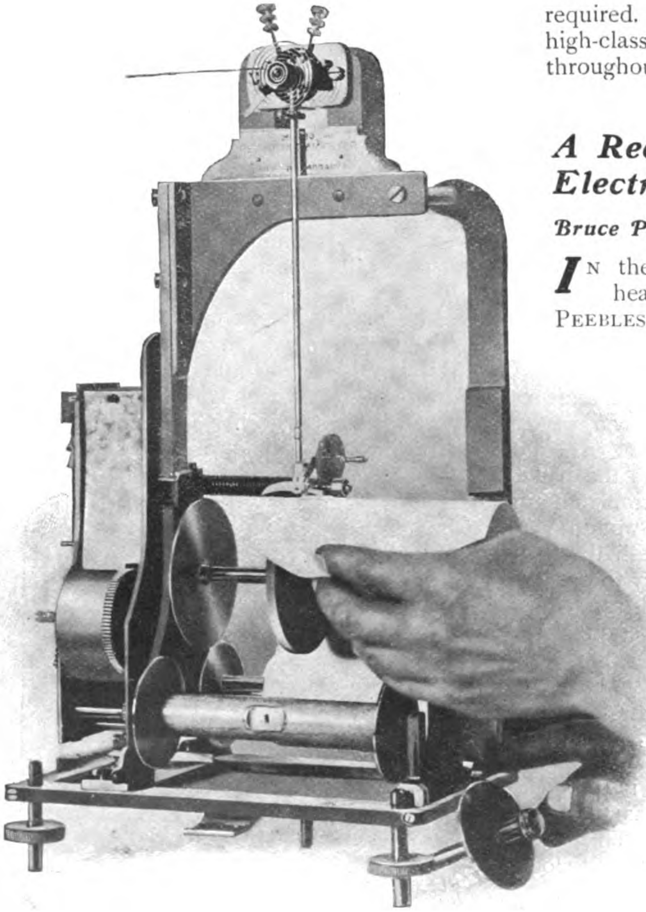
In the switchboard type (Fig. 1) the lower part of case slides upwards so as to "telescope" over the upper part. This gives access to the paper spools, pen, and clockwork. In this way the case occupies no more space when open than closed.

The electrical movement is very simple and consists of two solenoids, into which are drawn soft iron cores attached to a beam on the spindle of the pen lever. The pull is exerted against a phosphor bronze spring, and owing to the special form of solenoids and construction of other parts, a practically equal scale is produced, while hysteresis is reduced to a negligible quantity. The movement of the cores within the solenoids gives a strong damping effect, so much so that the system is more dead beat than a moving coil movement under similar conditions. The pen hangs on knife edges within the stirrup on the end of the pen lever, and moves across the paper in a straight line, consequently the time divisions are also straight lines across the diagram. The special form of pen carries a large supply of ink, and its construction renders it extremely easy to clean whenever it becomes clogged with thickened ink or dust. The clockwork is of the pendulum type—strong and simple in construction, and will run fourteen days with one winding. The roll of paper is supplied in the form of a cylinder, 4½in. wide, 2in. in diameter, and with a ¾in. hole; its length is approximately 20 yards. When moving at the normal rate of 1in. per hour, one roll will last for 30 days.

The end of the back spool draws off so that a new roll of paper can be slipped on the spool. To insert a roll (Fig. 2), the outer end of the diagram is unrolled for a few inches before sliding it into position, and the rubber wheel is raised well clear of the driving wheel. The unrolled end is then slipped along sideways over the



Holmes Switchboard Type of Recording Voltmeter.



Interior of Holmes Recording Ammeter, showing Method of Inserting Paper.

driving wheel, while at the same time the roll is pushed into position on its spool. The end of the diagram is now drawn downwards until it can be pressed on to the small hook put in the middle of the front winding-spool for that purpose.

For recording ammeters of forty amperes and upwards, a moving-coil system is used in place of the solenoid movement, and outside shunts with lengths of flexible connectors are supplied. Portable voltmeters have the resistances self-contained up to 300 volts: above that voltage separate resistance boxes are added.

Any special speed of paper can be supplied, or two speeds may be combined in the one recorder, such as 1in. and 3in., or 1in. and 6in. per hour. Specially rapid speeds of 6in. and 12in. per minute can be arranged if required. The instruments are all of high-class workmanship and well-finished throughout.

◆

A Record in Heavy Electrical Work.

Bruce Peebles & Co., Limited.

In the matter of power plants and heavy electrical machinery, Bruce Peebles & Co., Ltd., East Pilton, Edinburgh, have dealt with numerous large and important orders during the year. Two Scotch power schemes, the Scottish Central Electric Power Company and the Fife Electric Power Company, have been equipped by them with up-to-date generating plant. The stations are practically duplicates of each other, their output being 800kw. each in two 400kw. Willans-Peebles engine-driven alternator sets. The Scottish Central is also installing two 1500kw. Peebles alternators which will be turbine driven. The Durham Collieries Electric Power Company has been supplied with five 2000h.p. Peebles turbo-alternators for power supply chiefly to the Lambton Collieries and also the Sunderland District Tramways. A feature of the hauling plant for these collieries, which will be of Bruce Peebles make, is the supply of a special liquid controller by which creeping speeds can be given to the hauling rope. A large main winding engine has been installed at Cobbinshaw Pit, of the Tarbrax Oil Company, and is the first heavy electrical example to go down in this country.

In electric traction circles, the Falkirk and Sunderland and District Tramways have been installed with Peebles plant throughout from dynamos to car controllers. Light traction, however, by no means exhausts the capabilities of the company in electric transport, as it is making the entire equipment for a standard gauge railway in Canada, to operate on the three-phase system. The motors are of the duplex type, and will run on direct currents also. The complete system of tramways for Shanghai is to be equipped with Peebles plant, the order, the largest for export of electrical apparatus ever placed, amounting to £400,000.

We must not forget to mention before closing the pioneer hydro-electric power plant which Messrs. Bruce Peebles are completing in North Wales. The four water-wheel sets will operate under a head of 1100ft., and drive generators aggregating 1500kw. The waters of Llyn Llydaw are being used for the scheme, and the power will be transmitted for fifteen miles in the neighbouring slate quarries. A thirty-mile narrow-gauge polyphase railway will also be operated at 600 volts from the same station.

◆

Steam Users Specialities.

Messrs. Lancaster & Tonge.

The gradual revival in the trade of the country during the past year brought with it a steadily increased demand for "The Lancaster" specialities. Despite the fact that there are now a large number of steam traps on the market, "The Lancaster" steam traps still continue to enlarge their almost universal popularity, and during 1905 over 2400 have been sold. Messrs. Lancaster & Tonge's improved design of steam trap, "The Lancaster" 1903 Patent, appears to be making extremely rapid growth in the favour of engineers and manufacturers, and, though it has been on the market little more than two years, last year's orders totalled over 1000 traps.

"The Lancaster" Metallic Packings still continue to be largely taken up by the leading engineers, colliery owners, and manufacturers. They are now working with great success on the largest cotton mill engines in the world. "The Lancaster" piston rings and springs, also steam dryers, have made very substantial progress. Last March Messrs. Lancaster & Tonge despatched to Japan one of the largest steam dryers they have yet made, the bore of the pipe being 15in. These steam dryers have proved highly successful in connection with steam turbine installations, and are being largely used by the leading steam turbine makers.

During 1905 Messrs. Lancaster & Tonge have added a new feature to their business, namely, the manufacture of machine moulded wheels, for which they possess a large foundry equipped with the latest machinery. They have acquired the whole of the tooth block patterns (1160 in number) of Messrs. John Fletcher & Sons, Eagle Foundry, Salford, and are now in a position to give prompt deliveries of any kind of wheel. Our readers interested in this class of machinery should apply to the firm for full particulars.

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The New Firm of Graham, Morton & Co., Leeds.

In our June issue we referred in an editorial note to the action fought by Graham, Morton & Co., Ltd., against the Compagnie L'Union des Gas, Milan, from which the former emerged victorious on every point, and with its commercial reputation considerably enhanced. We now understand that this nefarious piece of business has encompassed the downfall of the old firm, and necessitated its voluntary winding up quite recently. The action, it appears, cost the company indirectly over £30,000, and so disorganised the conduct of business that, in addition, trading results were greatly impaired and a loss imposed on the last financial year's working. Several appeals to the shareholders to keep the concern from complete collapse failed to find adequate response, and, despite the fact that the company held a matter of £140,000 worth of uncompleted and remunerative orders, the business has been allowed to get into the liquidator's hands.

We hardly need remind our readers of the great reputation which Messrs. Graham, Morton have built up for themselves, nor of the enterprise and zeal they displayed in erecting their splendid Leeds works in record time. A sound and flourishing business was but the just reward of persistent effort and well-directed organization. It seems, therefore, to say the least, a mistake for those who could have mitigated the consequences of a regrettable misfortune, to desert the undertaking in time of its greatest need. From all the facts to hand, however, we are convinced that the managing directors, Mr. Maurice Graham and Mr. Joseph Morton, have spared neither time, expense, or direct personal effort to retrieve the position of the company. Mr. Graham himself has lost over £36,000 in fighting for his own reputation and that of his firm, but we are very glad to see he is still "game," and his decision to commence again will command the admiration of the industry at large. Under the title of "Graham, Morton & Co." he will undertake the work of reconstructing the business, and though his task will be no light one, it is well worthy of his capacity and skill, and will we are convinced be materially relieved by the practical sympathy of his many friends. We wish him in his new enterprise a fuller measure of reward than has been meted out to him in the past, and feel confident that the name Graham, Morton & Co., will not disappear from our trade annals for want of support from the engineering industry throughout the world.

Colliery and Pumping Plant.

Ernest Scott & Mountain, Limited.

The opening of the new works of this firm took place on the 19th May, 1905, when about 500 visitors were present, and a considerable show of machinery completed in the new works was inspected (see The Electrical Magazine, June, 1905).

During the past year the firm have completed some very large contracts, including, amongst others, the following:—Electric generating machinery for Messrs. Bell Bros., Ltd., Iron and Steel Works, Port Clarence, consisting of a 450kw. (600 electrical horse-power) continuous-current dynamo mounted on the crank shaft of a horizontal slow-speed steam engine. A similar set with coupled compound engines of Messrs. Robey & Co.'s make was also supplied to the same station. For the Consett Iron Co, County Durham, the firm have completed what is believed to be the largest pumping installation in the country. This plant consists of two Scott & Mountain 500h.p. three-crank compound enclosed engines and dynamos which supply power and current for driving the pumps, and also for electric lighting throughout the works. The pumping station is situated about 1000 yards from the engine house, and adjoins the two new reservoirs which have been constructed by the Consett Co. In the pump house there are three three-throw ram pumps, these being exceptionally heavy, and having a capacity of 1500 to 2000 gallons of water per minute, while working against a head of 300ft. Some idea of the size of these pumps may be gained when it is stated that each pump will lift very nearly sufficient water per day for a population of 100,000 people on the ordinary town allowance of thirty gallons per day per head. The whole of the installation, including the engines, dynamos, pumps, and motors, was made by Scott & Mountain in their new works.

Messrs. Scott & Mountain have also supplied to Messrs. Cammell, Laird & Co., of Sheffield, one of their high-speed enclosed compound engines direct coupled to one of their dynamos of 450kw. capacity, and also another generator of similar size for mounting on the crank shaft of a compound slow-speed horizontal engine. At the present time Messrs. Scott & Mountain are completing an important contract for the Alquife Mine and Railway Co. of Spain. These mines are the property of the Coltness Iron Co., of Glasgow, and the Millom & Askam Co., of Cumberland, and the whole plant will be driven by electric current generated by water power in the district.

Other important work now in hand includes a very large colliery installation for the Wigan Coal and Iron Co. for their Manton Colliery, this plant consisting of two three-phase generators directly mounted on the crank shafts of slow-speed engines, each having a capacity of 500kw. (650h.p.). This installation includes pumps, haulage gears, and other auxiliary machinery in the colliery.

The firm's operations are not confined to the United Kingdom, but include, as mentioned above, the plant for the Alquife Mines in Spain, and also a large and important contract for the Bengal Coal Co., India, this latter plant consisting of electrically driven haulage and winding gears, pumps, &c., such as they are in the habit of supplying for colliery work. It is of course impossible in a short article of this nature to enumerate more than a small part of the work which Messrs. Scott & Mountain have in hand, but when it is stated that their machinery is now being supplied to many of the largest colliery companies in this country and abroad, as well as considerable shipments to China, Straits Settlements, Australia, New Zealand, The Cape, &c., it will be seen that the business of the firm is in a very prosperous condition.

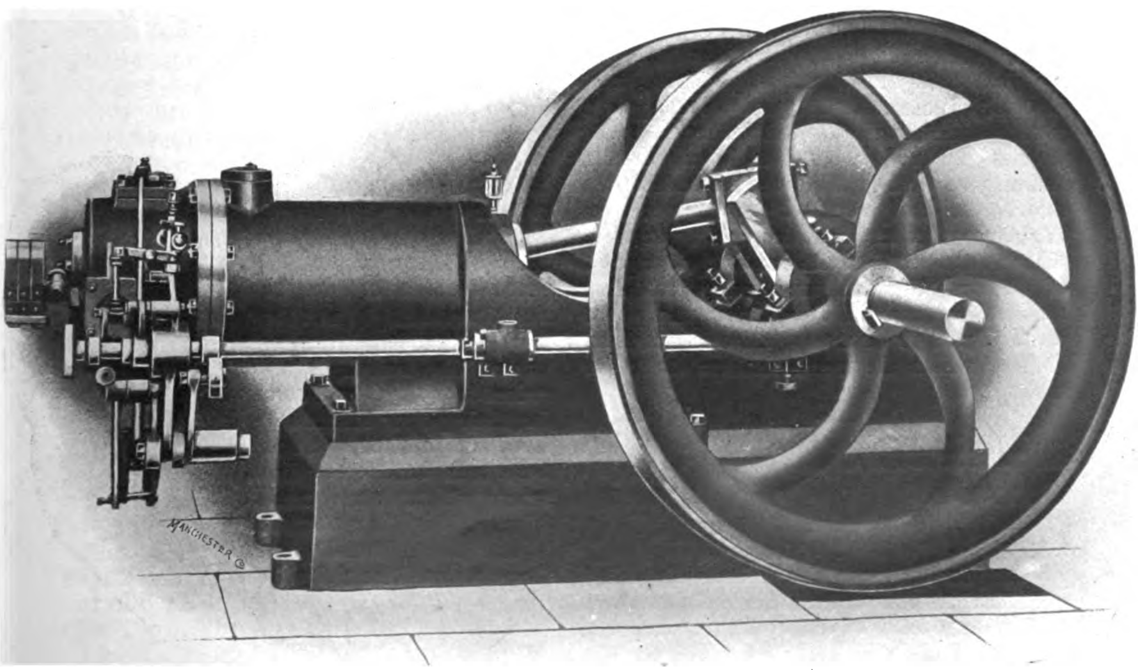
The new works at Gateshead have been constructed so as to allow of future extensions as the business develops, and are arranged to deal with the largest class of machinery which is being at present constructed for electrical work, or is likely to be undertaken either in this country or abroad.

Gas & Oil Engine Manufacture.

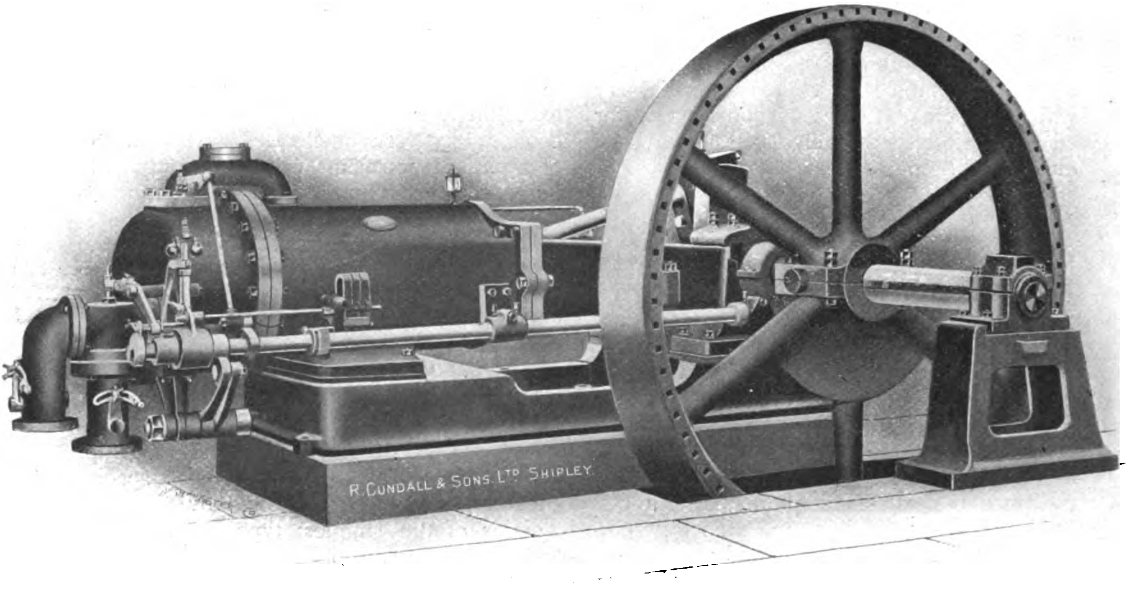
R. Cundall & Sons, Ltd.

THE field of utility of the modern oil engine is being constantly extended. This class of prime mover has always appealed to the electrical engineer because of its extreme simplicity. It requires neither coal nor boilers, steam piping, or chimney stack. It is probably more extensively employed in places where coal and gas are not readily obtainable, and in this respect has considerable vogue in the lighting of country houses. Messrs. R. Cundall & Sons, Ltd., Airedale Ironworks, Shipley, have done a very extensive business with their now famous oil engine during the past year. Their new works have been kept busy turning out engines of all sizes, and we may state that a standard line is exploited of engines from one-and-a-half to 300b h.p. The engine is exceedingly simple, and in the matter of economy is very efficient. Three-quarters of a pint of petroleum will, according to the makers, give 1b.h.p. an hour, representing a cost of about ½d.

Gas engines are also a speciality of the firm, these being built in sizes from 10 to 300h.p. They are of the horizontal pattern, and in the larger types the cylinders are placed *vis-à-vis*, this being found the best arrangement. It is interesting to note that tube ignition has been abandoned for a magneto and electric spark. This materially reduces the time required for starting up. In conjunction with these engines a special suction gas plant is exploited by the firm. This is of the simplest type, and requires little or no attention. The design is based on the idea of economising floor space as much as possible. Welsh anthracite is the fuel employed, and in the larger installations gas coke may be used. With the cost of the former at £1 per ton, 1b.h.p. per hour can be obtained for under $\frac{1}{10}$ of 1d.



TYPE OF CUNDALL GAS ENGINE FOR CAPACITIES FROM 10-50B.H.P.


R. CUNDALL & SONS. LTD SHIPLEY

Large Pattern of Cundall Horizontal Gas Engine.

If gas coke is used this cost is considerably reduced. We understand that very extensive use is being made of these suction gas plants, and that a considerable number is being sent abroad. For country house installations for the driving of dynamos, pumping, and general purposes, these engines are doing very good service. Their design has been carefully worked out with a view to giving steady running, so that lighting can be undertaken direct from the dynamo without the necessity for accumulators. It is interesting to note that in both respects the gas and oil engines of Messrs. Cundall are giving complete satisfaction, and in every way justify the claims for high economy, efficiency, and reliability which the manufacturers make for them.

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Mechanical Stoking Records.

Ed. Bennis & Co., Ltd.

The year 1905 saw Messrs. Bennis installed in their new works at Little Hulton, near Bolton, and with a bright outlook as to the increase of trade in the coming year. The general trade revival has, we understand, affected them by sending them work from practically every branch of trade. The colliery owners more particularly are bringing their works up to date and spending large sums upon the proper equipment of boiler houses, with well designed mechanical stoking and coal and ash conveying plant, enabling them to use slacks or smudges formerly thrown away as waste upon the pit heaps, and also to economise labour. It may safely be said that boiler houses in connection with collieries have been usually one of the chief sources of waste; coal is cheap and scattered all over the place, and, therefore, has not been valued. At least eight large and important collieries have been fitted up with machine stoking plants supplied by the company, and a large number of steel and iron works. The British Government has placed orders for forty-four Bennis machine stokers for their power stations at Portsmouth and Chatham, and many electric lighting stations have been fitted up by them during the year, among which we may mention: the Sheffield Electric Lighting Station, Neepsend; the Wimbledon Electricity Station; the Dublin Corporation Electricity Station; the Rugby Urban District Council; Woking Electric Supply Co., Ltd.; the Corporation of Blackpool Electricity Station.

The company has largely extended its field in elevating and conveying plant, and built during the year about £16,000 worth of band conveyors for the Dunderland Iron Ore Co., Ltd.

The tendency, we are glad to state, has been for the user of conveying or elevating plant to adopt better methods and more substantially built conveyors, etc., than has been the case in the past, and as Messrs. Bennis have long stood out against cheap light methods of manufacture, this has tended to throw a great deal of work into their hands.

Amongst the work that was carried out during the past year we may mention the coal bunkers for the Powell Duffryn Steam Coal Co., Ltd., with a 15,000 gallon tank on top, the total height being over 80ft. for their washery plant. A complete coal and ash handling plant for the Borough of Hammersmith, London. Complete coal handling plant for the Northampton Electric Light and Power Co., Ltd. Complete coal handling plant for Nobels Explosives Co., Ltd., Ansell's Brewery, Ltd., Mark Oldroyd and Sons, Ltd., Dewsbury, and several plants for the Patent Shaft and Axletree Co., Ltd., Wednesbury.

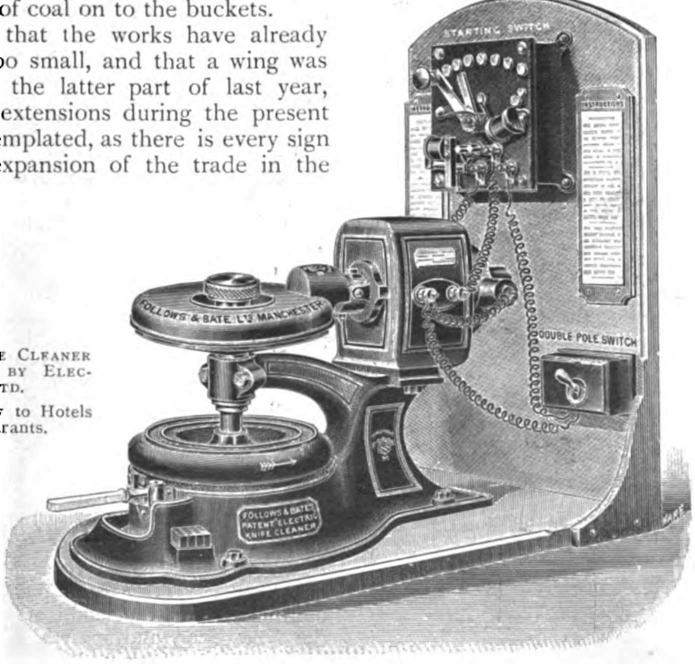
A system introduced during the past year of fitting single elevators to feed each boiler and driving them separately has been largely adopted, each elevator being built on the same substantial lines as the large ones, and fitted with the same safety gear for preventing an inrush of coal on to the buckets.

We gather that the works have already been found too small, and that a wing was added during the latter part of last year, while further extensions during the present year are contemplated, as there is every sign of a further expansion of the trade in the country.

Motor Manufacture.

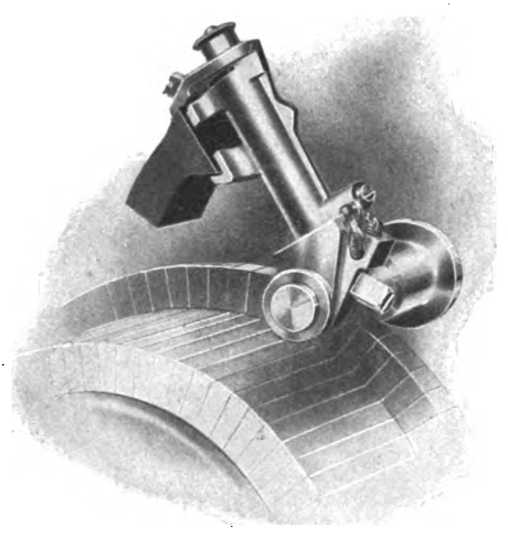
Electromotors Limited.

Among the many electrical firms who keep up with the times we may mention the name of Electromotors Ltd., of Openshaw, Manchester. Perhaps the most noticeable feature of their machines this year is the much enlarged diameter of the shutter over the commutator giving an improved access to the brushes and working parts. We have already called attention in these pages to their new brush holder, which seems to us to be as nearly perfect as such a device can be, and we are pleased to hear that subsequent experience has borne out our previous convictions of its sterling merit and efficiency. What struck us most forcibly at the Olympia Exhibition last year was the immense increase in the number of motors used for general and domestic purposes, and here again we could not fail to notice the name of Electromotors Ltd. On no stand was such variety of design and application more noticeable than on theirs. Among the many specialities which they have put on the market this year we notice a complete range of electric fans, and the importance of these in the factory, hotel, and even private houses we have always laid stress upon. Two other


STARTING SWITCH
INSTRUCTIONS
DOUBLE POLE SWITCH
FOLLOWS & BATE LTD MANCHESTER
FOLLOWS & BATE PATENT ELECTRIC KNIFE CLEANER

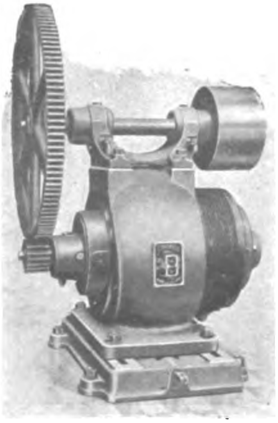
Electric Knife Cleaner with Motor by Electromotors, Ltd.

Supplied largely to Hotels and Restaurants.



The Latest Thing in Brush Holders as Fitted to the Standard Motors of Electromotors, Ltd.

specialities for a similar field of application have attracted our attention, viz., the boot polishing motor and the buffing machine, the usefulness of which it is needless for us to call attention to. Other articles worthy of note in the list of new apparatus is a very high-class knife cleaner and also service hoists, examples of which were exhibited at Olympia. We understand that the company have secured during the past year several large motor installations for driving works, description of which we must reserve for some future issue.



Standard Back-Geared Motor of Electromotors, Ltd.

New Catalogues.

Any of the firms mentioned below will forward the literature reviewed under this heading on receipt of a post-card request for same.

Alternators.—The General Electric Co., Ltd., Queen Victoria Street, E.C. A booklet forming section P of the G.E.C. catalogue is to hand, and deals with one-, two-, and three-phase generating plant built at the Witton works of the company. A tabulated price list precedes the general illustrated matter, which is very well got up. The company has done some good work in alternator construction, and is to be congratulated on entering a field at one time regarded as the exclusive domain of foreign manufacturers.

Knife Switches.—Ferranti, Ltd., Hollinwood, Lancs. Catalogue No. 55 is a six-page pamphlet describing, pricing, and illustrating the company's triple-pole double-throw quick-break knife switches. The capacities range from 25 to 2,500 amperes, and any voltage up to 650.

Fire Tests.—British Fire Prevention Committee, 1, Waterloo Place, Pall Mall. "Red book" No. 101 gives details and illustrations of fire tests with concrete floors. Seven samples were tested, and some valuable data collected as the result. Full particulars are given in the booklet.

Calendar. — Industrial Engineering Co., Exchange Building, Manchester. We have to acknowledge receipt of a handsome embossed copper calendar from this firm. It is a novel idea for bringing the name of the company forward, and should find its way into every engineer's office. Gas suction plants and dynamo electric machinery are the specialities of the company (see p. 70).

Motor Starters and Accessories. — A. Reyrolle & Co., Ltd., Hebburn-on-Tyne. A handsome file of price leaflets and descriptive data regarding this company's motor starters and other motor accessories is just added to our already bulging portfolio of catalogues. The file cover is attractively got up and should prove irresistible, even to parties whose bump of enquiry is not well developed. The indestructible resistance unit figures prominently in the list, and the cast-iron wall-plugs which made such an impression—on the floor—at Olympia, are also specially starred. Motor users will save money by getting this list, and if they get the articles it describes they will also economize language, strong language we mean.

Desk Diary.—General Electric Co., Ltd., Queen Victoria Street, E.C. Ideas in novelties for calendars, pocket books, and blotting pads go the round of manufacturers at the New Year, and something new generally

For 1906.

The Lesson of History.

Progress

is the law of our existence. If we stand still we are on an inclined plane and must go back! ¶ British Electrical Manufacturers are being assailed on every hand. The rivalry among themselves is being accentuated daily by the acute competition of foreign firms not only in this country, but throughout the markets of the world. ¶ What are our manufacturers doing to keep their end up? ¶ What are they doing to retain their old customers and broaden their field of operations? Everyone making anything worth selling is adopting some method of publicity. It is necessary, nay imperative. But the cost is often heavy, and a lot of money is being unremuneratively spent. ¶ By extensive plans which the proprietors of The ELECTRICAL MAGAZINE have on hand, manufacturers can be assured of maximum publicity, forcefully and intelligently directed, among the right kind of buyers at minimum cost. This organization is, in fact, in a position to guarantee British Electrical manufacturers a saving of fully half their publicity expenditure for at least a year. Before you make any new advertising engagements for 1906, write us.

A Great Scheme

to retain and EXPAND your Trade.

turns up. This may be said of the engagement desk diary presented by the above company. On the right-hand pages are spaces for two days, and the left hand is given up to more or less pointed and descriptive references to G.E.C. products. We shall find it very useful until something else comes from the same quarter to take its place.

Train Lighting.—MATHER AND PLATT, LTD., Manchester. A complete descriptive account of the Rosenberg train-lighting system, which is being taken up by this well-known firm, is contained in an attractive booklet. For neatness we find Mather and Platt's circulars hard to beat, while their consistent uniformity is a characteristic of the concern itself. The chief features of the system reside in the use of a special dynamo, which is independent of speed variation, and a single battery only instead of the two common to most systems. An equipment for 14 to 20 lights weighs 20cwt. complete, and for 36 to 45 lights only 6cwt. is added. The company is prepared, judging by its specification, to supply complete equipments from dynamo to lamps inclusive.

E. P. S. Blotter.—ELECTRICAL POWER STORAGE CO, LTD., 4, Great Winchester Street, E.C. The E. P. S. blotter has now become an institution in electrical affairs. We simply could not exist without it. The 1906 number is as good as its predecessors and will serve us during the next twelve months better than ever. We miss, however, the knight in armour who graced the diary cover in days of yore. Chivalry is not surely dead since the Edison battery appeared.

Lamps of all kinds.—DRAKE & GORHAM, LTD., 66, Victoria Street, Westminster, S.W. Four pamphlets have reached us, describing and pricing the Nernst lamps, Jandus lamps, and tantalum lamps exploited by this company. The Nernst lamp booklet is very complete and the illustrations are excellent. A wide range of patterns is offered, from the largest to the smallest lamps, and with fittings both plain and ornate. The latter are especially handsome and should tend to popularise the Nernst lamp for something more than plain pendant work. The Jandus price lists give particulars of a new a. c. lamp and new designs in d. c. patterns.

Recording Instruments.—NALDER BROS. AND THOMPSON, LTD., 34, Queen Street, Cheapside, E.C. Section III. of this company's latest price list is to hand, and deals with recording instruments. These include ammeters and voltmeters for d. c. and a. c. circuits, and are of the solenoid and moving coil types. The list is well got up and clearly illustrated. Every central station engineer should procure a copy. (See p. 66.)

Calendar.—R. W. VICAREY, LTD., 15, Queen Street, Cheapside, E.C., send us a neat and artistic strip calendar for 1906. The company are accumulator experts and analysts.

The Motorgraphe. — ELECTROMOTORS, LTD., Openshaw, Manchester. The Motorgraphe is a mechanical model shaped after a standard Electromotor motor carcase and is intended to be a continuous index of the sizes required for a given h.p. and r.p.m. The centre or "armature" revolves within the field, and letters on the marked "poles," which, however, are of widely varying pitch, indicate the standard motor letter for motors from ¼ to 25h.p., and speeds between 2000 and 300r.p.m. User and non-users of Electromotors should secure a copy.

Motors & Dynamos.—ELECTROMOTORS, LTD., Openshaw, Manchester. A complete price list of standard motors and dynamos. These include semi-enclosed, enclosed ventilated, totally enclosed and crane motors; lift and hoist motors, worm and spur gear sets, and variable speed motors, also motor starters and accessories. The firm must be congratulated on the very complete method of standardization and classification adopted, and the lists and output tables are simplicity itself. Ordering is reduced to the statement of a letter and a few figures. Method on these lines can only lead to one thing—orders.

Motor Applications. — RICHARDSONS, WESTGARTH AND CO., LTD., Hartlepool. A handsome pamphlet on the electric driving of ring spinning frames is just to hand. It describes the system of Messrs. Brown, Boveri and Co., and gives full details and illustrations. It is suitable for either one or three phase current and consists of a separate motor for each machine.

Power in Bulk.—SCOTTISH CENTRAL ELECTRIC POWER COMPANY, 34, North Bridge Street, Edinburgh. A neat booklet issued recently by this company on the opening of its Bonnybridge Station has just come to hand. It contains a complete description of the works, distributing system, and Falkirk Tramways Substation; while an excellent section on electric power application makes it a useful piece of literature for canvassing purposes.

Steam Turbo-Calendar.—A. E. G. ELECTRICAL CO. OF SOUTH AFRICA, LTD., Charing Cross Road, W.C. Novelties in almanac and perpetual calendars will never cease to crowd the editorial table. We must, however, give preference to a young turbo-set which, if politely turned per diem, will record the total output—that is the day of the month. A model Zoelly turbine and generator could not be better adapted to such a purpose, for are not such machines always "up-to-date" and constantly turning? We congratulate the company on a decidedly novel plan of reminding engineers with reciprocating engines that they should keep on the move.

The
Electrical Magazine.

FOUNDED AND EDITED BY
THEO. FEILDEN.

VOL. V. NO. 2. (26th Issue.) LONDON. FEBRUARY 27, 1906.

The World's Electric Progress.

Hydro v. Steam. Electric Plants.

THE many imposing and extensive hydro-electric power stations now in operation in various parts of the world, convey the impression that electrical energy derived in this way from natural sources is cheaper and more reliable than steam. Experience in the erection and operation of water-power plants, however, produces diametrically opposite evidence and throws into strong relief the superior economy and reliability of steam, as at present practised; from the standpoint of economical working the hydro-electric plant is at a disadvantage, as large capital outlay on unprofitable works must be placed against the undertaking, and the cost and maintenance of transmission lines are items which militate against a low selling price. Figures as high as £20 per kw. for a hydro-electric plant are not exceptional, though it must be admitted that authentic data are not available regarding this important branch of electric power supply, to anything like the same extent as for steam plants. Until these are forthcoming a true comparison cannot be made, but it is safe to state that no hydro station has yet approached to the £8 per kw. suggested for one of the London bulk supply projects. Again the known charges for power from water plants are much higher than those prevailing in steam-operated systems. From all counts it looks a long way ahead when steam will be beaten from the field by water for electricity generation.

* * *

Canal Haulage.

THE duty of hauling heavy cargo boats on canals has always been regarded as specially reserved for electrical energy whenever railway companies were compelled to awake to the necessity for utilizing the waterways they own and allow to dilapidate. Schemes innumerable for electric tractors, electric tugs, towing cars, &c., at one time abounded, and from the wrack of mental effort a few isolated installations have been put down. There is talk of electrifying our own canal system when Government takes it over, but it remains to be seen if the new rival in the field will completely frustrate the long and carefully laid plans of electrical engineers; we refer to the suction-gas tug recently put into operation for canal boat towage. The appearance of an internal combustion engine tug seems to quite alter the case for electricity, especially in regard to that all-important item, initial capital expenditure. It were folly to disguise the preponderating difference in favour of "gas tugs" on grounds of initial capital expenditure, and even if greater economies could be shown with electric power, the prime cost and the time needed to get the system into working order would weigh against electric haulage. One cannot, of course, conceive of a combination of the two—gas and electric power—and it looks as if electricity must remain in the background until the day of the perfected battery and thermopile comes, when things will be levelled up a bit.

* * *

Central Station Economics.

THE idea of standardisation has saddled the central station engineer in some cases with what we might call a monotony of plant. Big units are the thing, and the dictates of fashion compel in addition a species of uniformity, so the sets are mostly all the same size. The turbine boom has, however, introduced a new factor, and with it uniformity must turn over a new leaf. A new set of rules must regulate the game, but there is yet another factor to reckon with among the pieces on the board, and that is the gas engine. The man with reciprocating steam plant cannot afford to ignore the turbo-generator or gas dynamo, but the question to him is, Can I effect a combination of the last two or compromise by calling in one or other to my aid during light-load time, say? This highly important problem has just been discussed before the American Institute of Electrical Engineers, and much valuable and instructive data were forthcoming both from the paper by Mr. Stott (referred to at length in Central Station Practice this month) and from the discussion. Until the improvement of the gas engine has been carried to a point which will admit of its wholesale adoption, a compromise with the steam turbine seems most feasible and was suggested by Mr. Stott as the result of experience with such a combination. He found that the turbine acted as a balancing set for load fluctuations. Again the jacket water from the gas engines can be used to feed the boiler while the exhaust gases can be made to heat the feed. For operating such a plant 46.32 is taken by Mr. Stott as against an assumed 100 for the reciprocating steam plant and 50.67 for a gas engine station. The gas-steam turbine proposition would then cut the station operating cost in two, which, though not the only item for economy, would by reduction materially decrease the total costs of the plant. We hope an experiment will be made with a plant on these lines and careful note taken of the capital outlay and operating and maintenance costs, for it seems to us to open up quite a new phase of the power-station problem.

A Typical and Striking Poster of the Chicago Electrical Exhibition.

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Chicago's Electrical Show.

The electrical interest of Chicago and district has recently brought to a conclusion a " show," or exhibition as we should term it, much on the lines of our Olympian display of last autumn. The show was open from Jan. 12th to Jan. 27th, and from reports now to hand upwards of 100,000 persons attended and manifested the keenest possible interest in the exhibits. As with Olympia, the display was organised to stimulate the demand for electricity from the supply mains, consequently the apparatus was chiefly of a light nature. President Roosevelt sent a wireless message which was the signal for commencing operations, and without any official inspection by the inhabitants of bumbledom, the opening ceremony was practically dispensed with. The event was widely advertised and some very artistic posters were "gotten up," and from those reproduced in various American journals we select the one adjoining as being the most effective. From an artistic point of view it is superior to the " Three Maids " which heralded the Olympic games, and it certainly seems more compelling. We also reproduce views of the interior and exterior of the Coliseum building as seen at night while the exhibition remained open. A monster revolving star, which can be seen as a huge luminous disc in the body of the illuminated hall, was one of the spectacles of the show. It was 25ft. 6in. in diameter, and was studded with over 300 incandescent lamps, ranging from

100 to 4-candle power, with frosted, plain, and coloured globes. The star was kept revolving at above 18-r.p.m., and various combinations of coloured lamps were turned on. Wireless telegraphy was in evidence, and aerograms could be despatched from the building, while, in addition, there was a good telephone service. A direct appeal was made to the public throughout the exhibition, and a daily paper known as The Electric City was printed and distributed by some thousands.

INTERIOR OF THE CHICAGO ELECTRICAL EXHIBITION AT NIGHT, SHOWING THE ILLUMINATING EFFECTS.

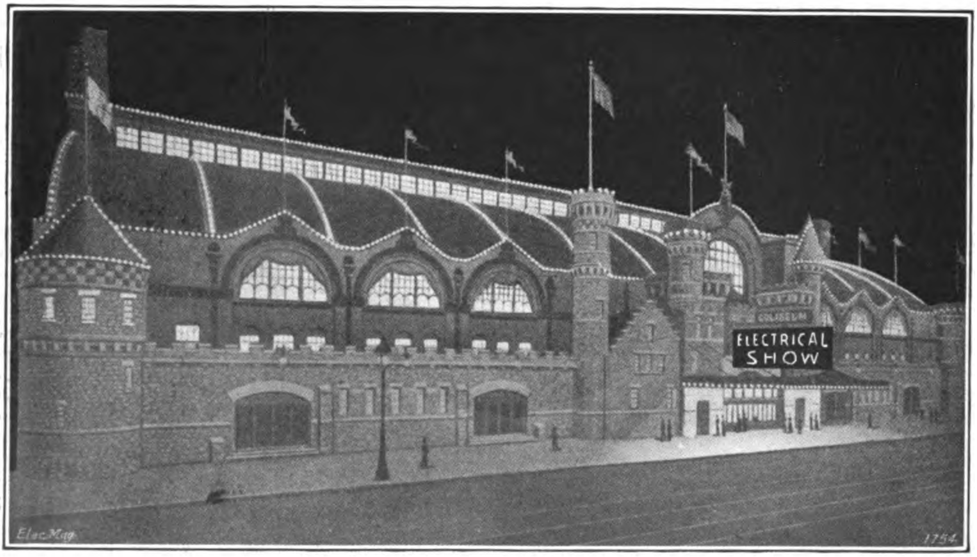
British Electric Tramways.

THE recent Government return giving statistics of electric tramways in the United Kingdom should be carefully studied by advocates of motor 'buses and prophets who hail the downfall of the electric tram. It is sometimes difficult for those who argue from the circumscribed area of their own knowledge, and who persistently ignore the facts as a whole, to realise what a hold electric tramways have upon this country, and accordingly what a gigantic task motor vehicles have of displacing them. Comparing the returns of the years 1878 and 1904, the extremes on the list of street and road tramways and light railways, we find that the capital expenditure has gone up from £4,207,350 to £52,675,152, and these figures vaguely convey that a great industry has arisen in our midst. The mileage of route has increased from 269 to 2117 miles, and the passengers carried from 146 millions to 2069 millions. Sir Herbert Jekyll, who contributes a prefatory note to the Return, states that the mileage for traffic has doubled since 1898, when electric trolley traction first came into use, and during the past year (1904) the increase in mileage was almost equal to the total tramway mileage during 1879. The total passengers carried now over all routes represent 48 times the entire population of the United Kingdom at the last census. The municipalities operate 174 undertakings, and companies 146, and the former contributed during 1904-5 nearly £210,000 to the relief of the rates. Curiously enough, of the old systems, horse traction claims a greater mileage (209) than steam, cable, or gas, while electric traction is easily ahead with 1780 miles out of a total of 2117 miles. We should like to see such figures as are embodied in the report put forward by advocates of motor 'buses, though we would be content if they would tell us what the cost of tyres is per mile run. While we admit that electric traction is not making the strides it did, we think it will be a long day before our many fine systems will give place to motor omnibuses.

* * *

Electricity in Paris.

PARIS, like London, is now beginning to suffer from the disorganization of its electricity-supply service. From all accounts there are not so many "cooks to spoil the broth" as in our own Metropolis, as only six companies are in the field; but these obtained the concession to supply under such peculiar circumstances that competition has not been possible. The eighteen years granted by the Paris authorities will expire this year, and electrical interests in the gay city are now all agog as to what shall be done. At the end of last year four offers were made by independent companies to the city, of schemes to consolidate the existing interests and evolve from the present muddle something like a systematic supply. We say "something like" because the service is now given from 2-3-4-5 wire distributing systems, and generation is from both alternate and direct current units, the former differing in periodicity with the particular section employing it. Of the four offers, one provides for a supply service over the entire city, excepting traction supply, and the promoters agree to hand over to the city 8 per cent. of the receipts, and 45 per cent. of the annual profits, the total income to the authorities being £150,000. The contract can be concluded at the end of 1923-1928 or 1933 as the city desires, but in the interim, the operating company will have entire control of the supply. What will actually transpire it is difficult at the moment to say, but we hope to see a consolidation of the existing undertakings, as being the most efficient solution of the problem.



EXTERIOR OF THE CHICAGO COLISEUM, ILLUMINATED ON THE OCCASION OF THE ELECTRICAL SHOW.

* * *

Benjamin Franklin.

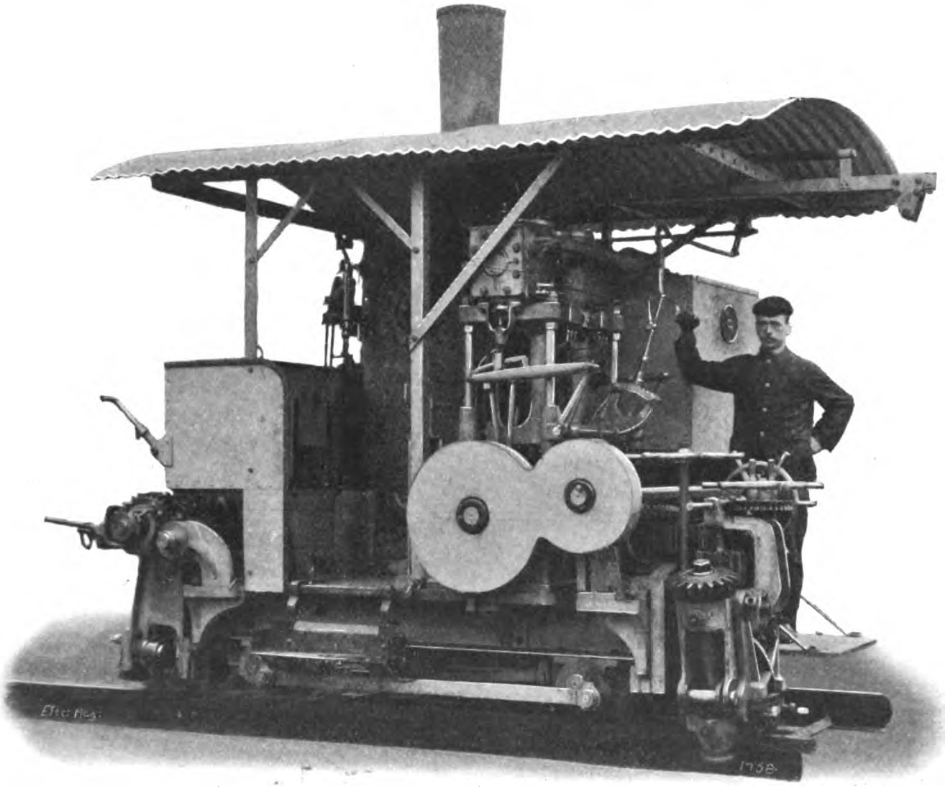
ON January 17, 1906, two centuries had elapsed since the birth of Benjamin Franklin, one of the most prominent and distinguished figures in electrical history. The occasion was made one of great commemoration in New York, Philadelphia, and other cities, and our American contemporaries devoted considerable space to matter bearing on the life and work of the great philosopher. The Electrical World especially published articles which emphasize the absence of evidence to substantiate the claims made for Franklin's now historical kite experiment. It is stated that the great man himself, his son, and his biographer and friends left nothing to attach the glory of "harnessing the lightning" to Franklin, and while this may, on the one hand, shake the faith of men in historical records as a whole, it cannot dissociate so remarkable a personality from an equally remarkable experiment in the minds of those with whom it must constantly live. Franklin's name must ever be coupled with the first practical electrical experiments, and this in itself, apart from corroborative details as to the conduct of any particular one, must place him beyond the reach of historical wreckers who pull the past to pieces not to redistribute credit where it is due but to break down the ideals surrounding the world's great men.

The Gas Turbine Problem.

DISCUSSION in the technical press has recently turned on the future of the gas turbine and advance towards the realisation of this desirable prime mover does not seem to be favoured thereby. The enormously high temperatures reached intermittently at the moment of explosion in a piston gas engine cannot be continuously reproduced in a turbine, for mechanical reasons; and this constitutes the main drawback. The introduction of steam to reduce the initial temperature of the gases involves a loss which cannot well be borne by the apparatus, and in fact anything in the nature of a compromise outside the real thing cannot be regarded with favour. On examination the main difficulties appear to be inherent in the problem and at the moment certainly impossible of removal. If real advance is to be made, then, it must be through the medium of combinations which will extend our experience of a type of prime mover differing in principle from anything now known. It would be preferable if these compromises could be confined to the testing laboratory and developed outside the operating field, but this is asking too much, and moreover, is contrary to our present methods of exploiting any piece of mechanism. The gradually improving all-round efficiency of the internal-combustion engine in the automobile and transport field would indicate that from this quarter something may come to throw light on the gas turbine problem. Certain it is that petrol motors have contributed to the solution of problems which at one time were considered impossible of elucidation, and the electrical industry has in some cases felt the benefit. So that, considered as a whole, the gas-turbine question is not such an impossible one as at first sight appears, and despite its inherent difficulties we need not yet despair of seeing them finally removed.

Central Station Publicity.

THE average central station in this country has been conducted since its inception on perfunctory lines from the commercial standpoint. The idea of publicity has never appealed to the engineer, who is after all a technical man and wrapped up in his works' costs. Obviously small undertakings cannot support both a technical and commercial manager, so there is nothing left for the technical head but to leave his works to a reliable assistant and study out the commercial problem for himself. He is hampered at the outset by that inherent insular prejudice of every Britisher against "making a show." The slow-going chief of a small works seems to shun the thought of publicity, regarding advertising as the thing for patent nostrums and the "manufacturer, dontcherknow." He overlooks his position as manufacturer through over-focus on his dignity as the chief engineer. He is a trader without the trading instinct, and has suffered for his ignorance. Electric lighting thus has been loaded with years of debt and loss, which might at least have meant a satisfactory turnover on the capital outlay. For years electric works have remained like ships without sails, drifting aimlessly in the broad sea of competition, awaiting the stimulus of steam to propel them forward. We do not forget that Britishers as a body are phlegmatic and hate ostentation, so that the fault is not all with that technical engineer. The mistake has rested mainly with the lack of thought for a development department as a real live asset to an undertaking, and many valuable years have slipped by which might have furnished results at this juncture. The cost of such a department should not be included merely in the annual figures, but spread out over a period of years, because the outlay is chargeable to the man who is coming on the mains next year and the year after. It is like a farmer distributing the cost of processes of sowing and growing over



ROMAPAC MACHINE FOR ROLLING ON AND CUTTING OFF HEAD OF COMPOUND TRAM-RAIL.

many months, rather than applying it to the particular months in which they actually transpired. After years of poor harvests, the electricity supply engineer is now learning the value of tilling and sowing the ground under his charge, and he may soon expect to reap a rich reward for his toil. He has learned that Mahomet will not come to the mountain, so the mountain must be taken to Mahomet. Customers will not come by force to the electricity works, but they can be persuaded to come by gentler methods.

❧

Renewable Tram Rails.

WHEN electric tramway traction became commercially possible, no serious thought was given to the renewing of the wearing surface of the rail when badly worn. We say "serious thought" because the idea of a compound rail with renewable head was certainly prevalent among tramway pioneers, but was never given practical shape for want of the means to carry out the project economically and efficiently. Now that many thousands of tons of tram rails have been laid and many hundreds scrapped through wear, a system is put forward, with all details carefully worked out, by which the working section of the rail is both applied and removed with a minimum expenditure of time and money. The seemingly inappropriate name of "Romapac" has been given to the system, which employs a special machine for rolling on the head rail, and for cutting it away when worn. Full details of the appliances employed with this interesting machine are given in Manufacturing Progress this month, and a view of the complete apparatus is reproduced on this page. It is yet too soon to postulate what reception the method will receive at the hands of tramway engineers, but from the demonstration of its capabilities which we recently witnessed, the machine fulfils all the claims of its inventor, and seems to us to fill a long-felt want in the tramway industry.

Electric Railway Engineering.

Mr. F. W. Carter's paper on this subject before the Institution of Electrical Engineers, though it made most difficult reading and had a very uninviting appearance, provoked a decidedly profitable discussion, and for this its other drawbacks may be overlooked. Mr. Carter was all for direct-current working, and made a good case for this system over suburban tracks. He had little to say in favour of one-phase methods, and even regarded them as quite unlikely of development for heavy continuous service. In this he failed to find support from the discussion because, as it was pointed out, the present aspect of one-phase working compared with only a few years ago pointed to a most encouraging future for motors employing one-phase currents. Mr. Philip Dawson and Mr. W. M. Mordey were especially denunciatory of the author's condemnation of one-phase railway motors. Both these experts complained of the quibbling now going on over mere motor efficiency, when the real question was the efficiency of the system as a whole. Mr. Trotter, of the Board of Trade, made some interesting remarks on alternate-current electrolysis and rail drop, but Mr. McMahon, who has had unique experience with three-wire railway working, considered that a good method of reducing the drop with one-phase working was to employ the three-wire system. This certainly has much to commend it. The author is quite right, in our opinion, when he says that "the operation of our main line trains would not be sensibly improved by electrification; certainly no such improvement would be anticipated as would justify the necessary greatoutlay of capital."

Greater London's Tramways.

The tramways around London are slowly but surely becoming interlinked, and before many months have elapsed several very important sections will be in touch with each other and the system as a whole. In the summer of last year we referred to the opening of the Erith electric trams, which served as a link with Woolwich and the L.C.C. systems, and now that particular connection is further extended into the country by the inauguration of an electric tramway service at Dartford. The new system couples with Erith by way of Bexley Heath and also is almost in touch with the Gravesend and Northfleet system on the north between it and the river Thames. A route mileage of some six miles on the overhead system has been laid down, and it is significant that the material throughout is of British manufacture. The construction calls for no special comment, as it is practically standardized. An extension has been made to the Council's power-house with plant to meet the tramway load, but this also includes nothing of a special character. The lines have been leased for 15 years to Messrs. J. G. White and Co., Ltd., who also were the principal contractors for the entire scheme. Among the sub-contractors were Ruston Proctor and Co., Ltd., boiler; Ferranti, Ltd., switchboard; Browett, Lindley and J. Fowler and Co., steam dynamo; and the Electrical Power Storage Co., Ltd., traction battery and booster. Through the courtesy of the contractors we were enabled to attend the inaugural ceremony, which passed off without the slightest hitch.

Electrified Canadian Pacific.

Countries abundantly blessed with water power such as the United States and Canada are in a position to think expansively on electrical affairs. We are dependent on coal for the bulk of our power, and when it comes to using that valuable agent for traction purposes we must rely on the steam locomotive. The Canadian Pacific Railway, however, is one of those privileged organisations which can set its managers the task of working out a scheme for the application of the many waterfalls along its route to operate the trains now drawn by steam. We understand that the substitution of electricity for steam as a motive power is under consideration by the Canadian Pacific Railway, and to that end officials of the road are in consultation with experts as to the advisability and probable cost of the change. If it is decided to take the plunge, a test will be begun within the next six months, the Montreal-Quebec section being first equipped. Should the experiment be successful the whole line of railway will gradually be converted into an electric road. The preliminary tests, according to present intention, will be made with Shawinigan Falls power, Niagara Falls power being afterwards drawn upon for operating the lines in Ontario. The desire of the

Canadian Pacific Railway to abandon steam is apparently due to the prospect now being rapidly realised of the Ontario field being covered by a network of electric lines which threaten both the passenger and freight business of the steam roads. It will be many a long year before we are rejoicing in a service of electric trains run from such central sources of power as our coal fields, through all of which express trains are now run.

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Sir Oliver Lodge on Radium.

SIR OLIVER LODGE made the following statement to a representative of the lay Press on the subject of radium :—"The fact that radium disintegrates and breaks down into other substances in the course of a few thousand years has, naturally, raised the question—How, then, does it happen that radium is still in existence? Why has it not already disappeared? And scientific men have been forced to conclude that by some means or other it is continually being reproduced, just as its own disintegrating products are being produced by its breakdown. Some of these last only a short time, others last longer; some being very unstable, and some more stable. It appears, therefore, quite possible, and even probable, that radium itself is a stage or episode, or temporary halting-place, in the breakdown of some other substance, and that other substance is probably uranium. It appears likely that uranium is disintegrating very slowly, and that one of its products is radium, which disintegrates very rapidly, but not so rapidly as the intervening stages, or as some of the subsequent stages. The act of breaking down is always associated with radioactivity and with intermediate substances, which are moderately stable and permanent, lasting a few thousand years, instead of only a few years or months or days, as in some instances is the case. These more permanent stages are those which have been discovered, and have acquired names. That is the present probable view of the history of these bodies—constantly being produced at one end and breaking down at the other, hence being necessarily rare; that is to say, found only in small quantities, and associated with the substances from which they originate."

INSTANTANEOUS PHOTO OF WATER JET AND WHEEL REVOLVING AT HIGH SPEED.

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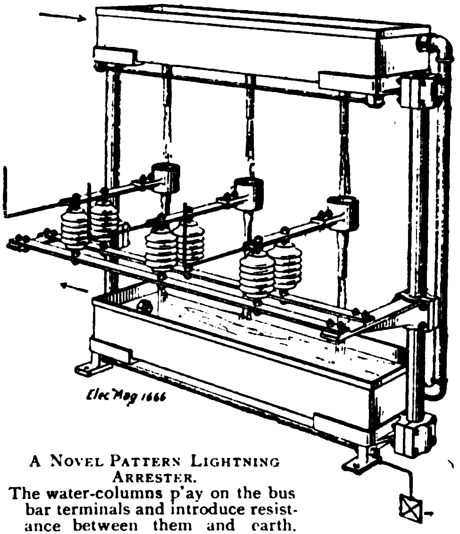
Water-jets and Water-wheels.

THE development of th jet type of water-turbine has given to hydro-electric stations a broader field of activity than would have been possible otherwise. The Western States of America can practically claim a monopoly of idea in building and exploiting this type of wheel for very large powers, and the conditions prevailing there have certainly favoured the movement. Exceptionally high heads of water are common out there, and, further, in some cases the driving of a bore-hole into the earth has brought up a column of water running into hundreds of feet high. It is presumed in the latter instances that the sources of water tapped are in subterranean communication with mountain lakes and consequently, when found an outlet, seek to reach their normal level. Advantage has been taken of this natural peculiarity to operate large wheels by jets attached to the bore-hole.



A NOVEL PATTERN LIGHTNING ARRESTER.
The water-columns play on the bus bar terminals and introduce resistance between them and earth. This is broken down when a flash occurs.

POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

The Question of the Gas Turbine.

By ROBERT M. NEILSON.

THE success of the steam turbine has led many engineers to expect success with turbines impelled by gaseous products of combustion. A gas engine using coal gas or producer gas, and having no reciprocating parts, would be a very desirable prime mover if it had an efficiency equal to that of existing gas engines of equal power. There are, however, formidable difficulties in the way of producing such a machine. With any gas engine, reciprocating or turbine, compression is necessary in order to obtain a good efficiency; and in reciprocating gas engines it has been found (as was to be expected from theoretical considerations) that the greater the compression, the greater the efficiency until practical developments (such as pre-ignition) came in to prevent higher compression. Now the higher the compression, the more important is it to have efficient compression. A rotary compressor which will be efficient for high pressures is therefore necessary before an efficient wholly-rotary gas engine can be produced. Now, we do not seem to have at present a satisfactory and efficient rotary compressor which can deliver air at, say, 100lb. per square inch. Turbine compressors, such as made by C. A. Parsons and Company in England, have much to be said for them, but unfortunately they do not seem to be efficient for high pressures.

The heat losses in a gas turbine demand serious consideration. Steam entering a steam turbine, even with a fairly high superheat, has a temperature very much below that existing in a gas engine combustion chamber. Water jacketing or other means are adopted in a reciprocating gas engine to keep the cylinder and other parts from getting overheated; and a certain amount of heat is thus lost which otherwise would have been converted into useful work. The gas, however, taken as a whole, is not brought into very intimate contact with the artificially cooled parts. If, however, a mass of intensely hot gas, such as usually exists in the centre of an Otto engine combustion chamber just after the beginning of the expansion stroke, were allowed to pass into a turbine, say, of the Parsons type, the blades of the turbine, even if they could be water-cooled sufficiently to stand the heat (which is doubtful in the case of some of them), would absorb such a quantity of heat energy from the gas as to leave comparatively little for conversion into useful power. The expansion of the hot gases in divergent nozzles and the mixing of them with a cooler fluid have been proposed, with a view to reducing the temperature of the gases before they reach the turbine proper.

In De Laval steam turbines, the steam, before coming into contact with the turbine wheel, is expanded in divergent nozzles from the initial pressure—say 200lb. per square inch—to approximately the exhaust pressure, which may be that of the atmosphere or of a good condenser. This expansion is done—and done very satisfactorily—in a single stage in divergent nozzles which convert the available heat energy (minus small losses due to friction, &c.) into kinetic energy. The steam issues with a very high velocity and a comparatively low temperature from the nozzles and, entering the turbine buckets, drives the wheel. If we were to expand gaseous products of combustion in divergent nozzles the same as is done with steam in De Laval steam turbines, we could with a suitable choice of working conditions obtain a temperature at the outlet ends of the nozzles such as a turbine wheel could stand. Our knowledge of the expansion of elastic fluids, other than steam, in divergent nozzles for use with turbine wheels is, however, almost nil; and experiments must be made before we can say with confidence whether as good results may be expected with gaseous products of combustion as can be obtained with steam.

The mixture of the hot gaseous products of combustion with water before use in a turbine would allow of the temperature being very much reduced. Unless, however, the ratio of water to gas were very high, the temperature of the resultant mixture would still be too great for it to be suitable for use in a turbine unless divergent nozzles were employed to reduce the temperature still further before the mixture was allowed to come into contact with the rotating vanes.

If the proportion of added water to products of combustion were great, then the fluid would be very much like superheated steam, which always contains, in practical steam-engine work, a certain amount of air. The turbine could then be built like any of the common forms of steam turbine, and a condenser could be employed. The non-condensable gases would have to be removed by an air pump; and the power to drive this air pump, which might be very considerable, would have to be taken into consideration.

The gas turbine problem is an interesting subject to all engineers and a fascinating one to many. Numerous inventive minds are engaged on the question, attempting to overcome the formidable obstacles in the way of success; and a few more years may—only the very optimistic will say more than "may"—present us with a successful gas turbine.

Mr. H. F. Schmidt, commenting in the same issue of Power from which Mr. Neilson's article is taken, refers to the mixed turbine as follows:

"The question of a mixed turbine—that is, one in which the gas is mixed with steam—presents rather a better future than Mr. Neilson is inclined to accord to it; it is difficult to agree with him in the statement that even with the admixture of steam it would be impossible to get sufficiently low temperatures. Certainly, if sufficient steam were mixed with the products of combustion, the temperature could be brought sufficiently low for use even in a reaction turbine, and surely in a turbine with one stage and giving complete expansion in the nozzles. Further, since there is an initial gain of about 20 per cent. over the steam turbine, there seems to be no reason to resort to condensation. Even though a large proportion of steam were added, the proportion of non-condensable gases would still be so great that the size of the air-pump and the considerable power required to drive it would leave little, if any, commercial gain. What would be better, and probably give nearly as good, if not better, results, would be to pass the exhaust from the turbine through an atmospheric condenser in which the feed-water for the turbine could be brought to a temperature corresponding to the pressure at which it was worked, and in the same manner the air and the fuel, if it were liquid or gaseous, could be pre-heated, thus utilising a large part of the heat in the exhaust and giving a corresponding gain in the efficiency. A turbine based on this principle is even now not out of reach, and a certain large company building steam turbines and working along these lines claims to have obtained results which compare favourably with the performance of the best steam turbines—and this with a machine which the builders have brought to practically a commercial footing."

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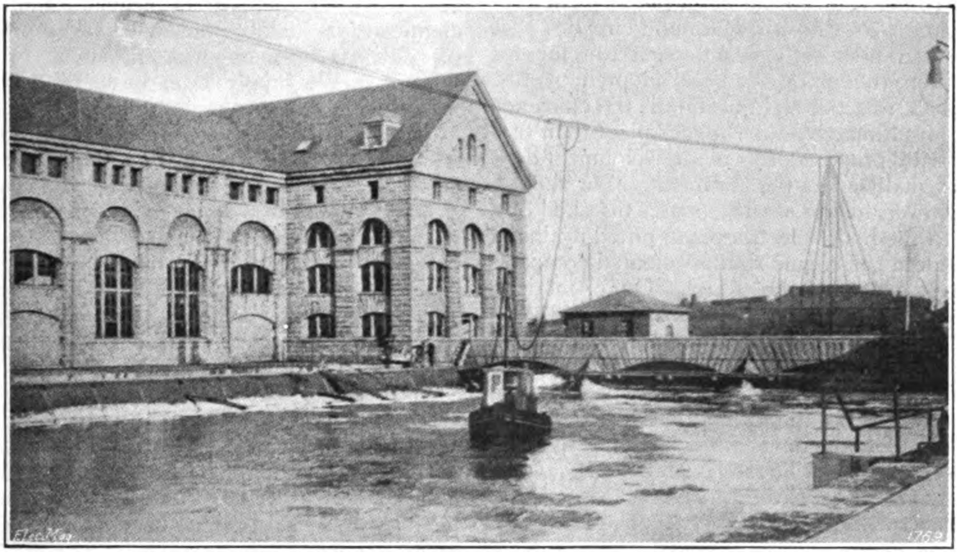
Victoria Falls to the Rand.

For the last three months a heated discussion has continued in the technical press on the transmission of Victoria Falls hydro-electric power over some 700 miles to the Rand. Interest was first created in the scheme by Prof. W. E. Ayrton, who gave out that the horse-power of the famous fall had been grossly exaggerated, and that but a tithe of what it was estimated to give might be expected from it. When all the facts were considered, this pronouncement was not seriously questioned, but when the Professor took open issue with the heads of the African Concessions Syndicate on the transmission of the power to the Rand, a storm at once burst upon the question at issue rather than on the man who had raised it. Statistics, figures, and estimates were flaunted by both sides, and in the turmoil the points of controversy were frequently lost sight of by those approving the scheme. The matter is one of considerable importance, and in briefly touching upon the subject, we may say that the promoters of the scheme have found little or no support in electrical circles, and particularly was this lacking in America, a quarter from which any statement on hydro-electricity can be treated with profound respect. If the Rand is to have electric power it is more than likely that a steam or gas-driven station will be erected in neighbouring coalfields, and a short transmission be availed of to give a cheap and efficient supply.

The more recent phases of the controversy have been confined to a discussion of the technical and commercial merits of the scheme by Mr. Robert Hammond and Mr. W. B. Esson, the former being the moving spirit in a steam station proposal to give power to the Rand from a short line. The battle ground was our contemporary the Electrical Review. Referring to a steam plant having an output of 87,500,000kw., with coal at 10s. 6d. a ton, and a consumption of 4lb. of coal per kilowatt-hour, Mr. Hammond gives the coal bill a figure of £91,875 a year, which compared with a figure of £200,000 given by Mr. Esson as the annual capital and maintenance cost of a 700 mile transmission line would represent a saving of £100,000 a year alone to the steam plant. Mr. Esson showed that power could be sold for ¾d. per kilowatt-hour, but interest on capital, maintenance, and renewals would represent .68d. per unit delivered to but not distributed over the Rand, and here Mr. Hammond regarded the allowance of .07d. per unit as insufficient to meet interest on distribution, capital, maintenance, and renewals. On all counts Mr. Hammond inveighed against the commercial practicability of the scheme. Mr. Esson in again taking up the cudgels argued that the comparative efficiencies of water and steam were not the point at issue, but "of two possible schemes the one which should be chosen is that which would give the lower cost as the ultimate output was reached, even if at first it gave a cost some-



A TROLLEY ICE-BREAKING BOAT AS USED BY THE NIAGARA FALLS POWER COMPANY.

The boat agitates the water by its motion and creates a current towards the overflow from the forebay. One-phase current is employed, and is reduced from 2000 volts to 200 by a transformer on the boat.

what higher." Evidently where these champions of water and steam fall foul of each other is on the matter of the output of the plant, Mr. Esson having an *ultimate* capacity of 80,000h.p., and Mr. Hammond one of 20,000h.p. The latter Mr. Esson contends would be useless for the Rand as it would merely constitute a beginning and would need to be reckoned as part of a more elaborate and extensive scheme. But Mr. Esson is almost sanguine of even the 20,000h.p. hydro-electric plant beating steam, as in Mr. Hammond's figures he includes an item of £19,000 for make up water which on Mr. Hammond's showing would give a saving of 10 per cent. to the water power plant over steam. To this, Mr. Hammond replies that he can now get coal at 5s. a ton for his station, though on the basis adopted by Mr. Esson, that the real question is the efficiency of an ultimately much greater plant than that initially proposed, this new development does not vitally affect the argument. We should, however, like to see the matter threshed out, with the hydro-electric plant pitted against a modern gas engine station situated comparatively close to the Rand. Our American contemporary the Electrical World has closely followed the controversy, and some editorial comments upon it are worth quoting. It says: "There is a fine appeal to the imagination in the former (the hydro-electric scheme) that counts for something even in these days of sordid money-grabbing. To take out of the heart of the African continent power from the mightiest cataract of the eastern hemisphere, and to transmit it more than twice as far as human enterprise has dared before, to the richest mines that ever tempted avarice, is a fact the thought of which quickens and tingles a little even the most stagnant blood. But capital is timid when working at its own risk, and the palmy days of African company promotion have passed. The success of the Victorian Falls project or of any other of like kind, turns entirely upon the line costs, which are mainly controllable by the practicable voltage. Hydraulic power is often very cheap merely because it is unutilizable by reason of its isolation. To render it valuable, high voltage is the thing that really counts, and by which most enterprises must stand or fall."

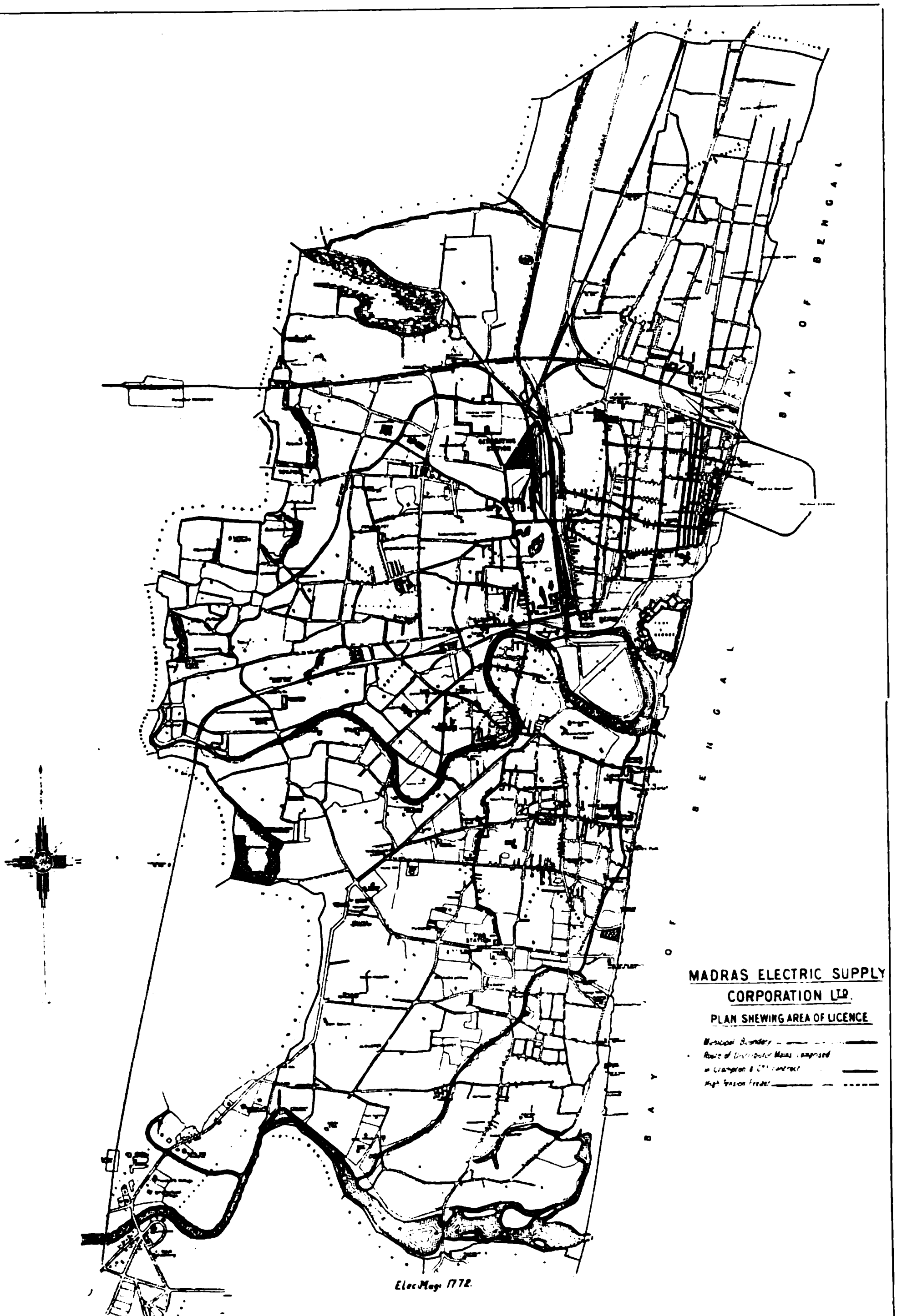
The developments of the immediate future will give answer to these vexed questions, and establish new standards in the known field of power transmission.

Electricity Supply in India.

ALTHOUGH India may be looked to in the future to rival Canada in the matter of hydro-electric developments, at the present time the bulk of the electric power supply is undertaken from steam-driven stations. The Cauvery Falls scheme, to which we have already referred, is the largest Indian hydro-electric plant in operation, though there are others in prospect, and the majority of them singularly enough are, or will be, equipped with other than British-made machinery. The large cities however furnish evidences of activity on the part of British electrical engineers, a notable instance being that of Calcutta, which was provided with electric power supply as early as 1899 and has since witnessed important extensions in its various areas. It is interesting to note that the cost of coal per unit has been reduced from 1.32d. to .42, a result which has contributed mainly to the large profits earned by the undertaking. Two steam stations are at present in operation, but a third is in course of erection in which modern turbo-generators will be installed. A fourth plant, employing suction gas producers plant, is also under construction.

So successful have all these plants proved that steps have now been taken to furnish the city of Madras—the third in the Indian Empire—with an electricity supply service. This movement is the outcome of the complete success of the Calcutta station especially in the matter of power supply for fans. The extensive use to which electric fans have been put in that city has contributed largely to improved health of the native population and to the comfort of Europeans. Madras is a city having no cold season, and for this reason a long hour power load for electric fans is anticipated, which will tend to make the supply very profitable. During 1904 the revenue from fans in Calcutta amounted to nearly £25,000, and as there is a cold season in that place, the prospects at Madras, which is without severe climatic change, are very encouraging, while, in addition, a good revenue is expected from a workshop load.

The Madras scheme is in the hands of Crompton & Co., Ltd., who so successfully engineered, organised, and managed the Calcutta undertaking, and who have now been granted a licence by the Government of

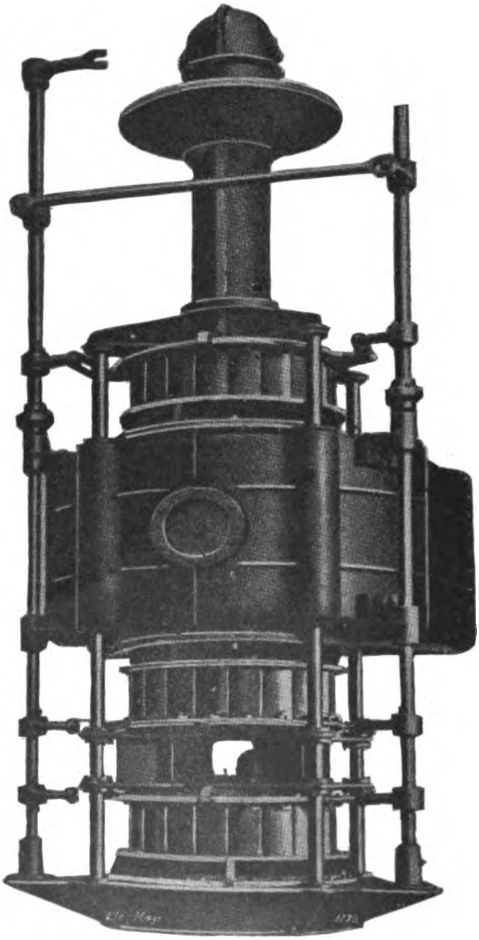

BAY OF BENGAL
BAY OF BENGAL
MADRAS ELECTRIC SUPPLY CORPORATION LTD.
PLAN SHEWING AREA OF LICENCE.
Municipal Boundary
Route of Distributor Mains comprised in Crompton & Co's contract
High Tension Feeder
Elec. Mag. 1772.

Madras for the supply of electricity in the city of Madras. A company has been formed, and such public confidence displayed on appeal for capital that the sum required has been considerably over-subscribed. We are indebted to Crompton & Co., Ltd., for the particulars from which this note is prepared, and for the map which we publish showing the area of supply.

We also understand from them that the licence covers the whole of the city within the municipal boundaries, the area being approximately 26½ square miles. The general system of supply will be the low-pressure direct-current three-wire system at 2 × 225 volts, but to meet the demand for current in bulk from mills, factories, and large consumers, there will be a three-phase supply at 5000 volts, with sub-stations where necessary reducing the pressure to 225 and 450 volts. The generating station will be designed on the most modern lines; direct-current plant of 2000kw. capacity and alternating current plant of 1500kw. capacity being installed in the first instance. The steam plant will be divided into units of 250 and 500kw. capacity, the engines working on 175lb. steam pressure and condensing. The boilers will be of the water-tube type, provided with chain grate stokers arranged for burning Indian coal. There will be one sub-station, with three 150kw. motor transformers.

A Novel Water Turbine.

The utilization of power from low and variable falls of water is still somewhat uncommon in hydro-electric practice, consequently some interest attaches to a special turbine designed for a normal fall of 16ft. at Sewall's Falls, New Haven, U.S.A. In flood times this working fall is reduced to 12ft., making a considerable difference in the head available. A triplex form of turbine has been adopted with three sets of runners and gates complete. The three sets of runners are all connected to the tail-race by means of draft tubes, so as to derive the full energy of the water, due to its actual head, from each of the runners, no matter what its relative or actual position may be upon the shaft. The lower runner of each wheel has a draft tube by itself, while a single tube of larger dimensions carries off the discharge water from the two upper runners. The turbines are of the Francis central discharge type. The three runners on each wheel are of equal size, form and capacity; but they do not all discharge in the same direction. The lower one discharges downwards into an individual concrete draft tube. The upper runner discharges downward and the middle one upward, both into a second concrete draft tube which joins the lower one at the bottom of the tail-race. The reactions from the upper two runners practically balance one another, while the reaction from the discharge of the lower runner, being upward, tends to lift a portion of the load on the turbine shaft. This effect is considered negligible in the turbine design, but provision is made for using the pressure due to the

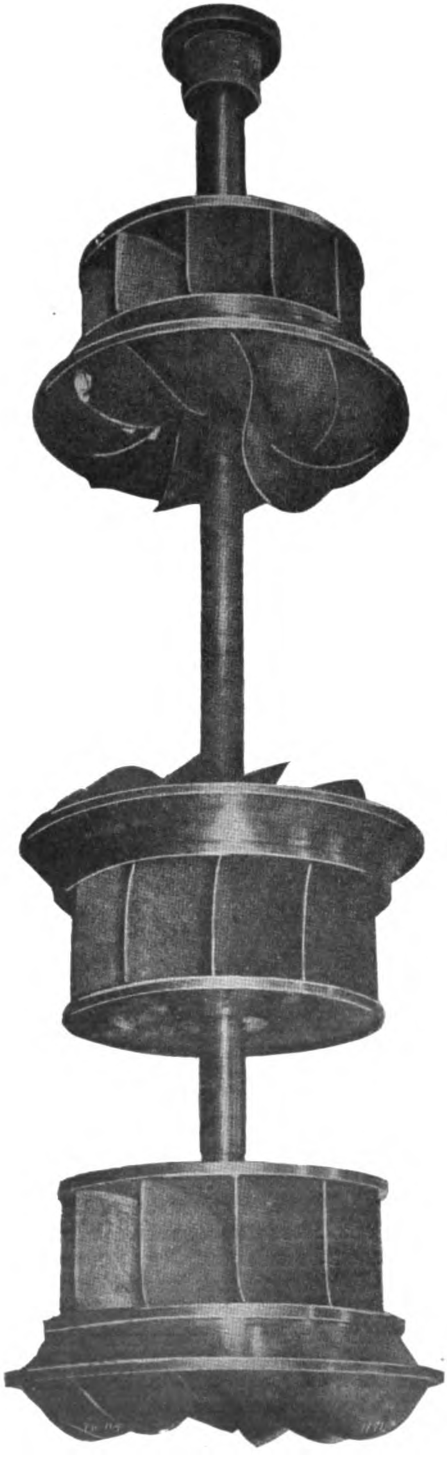


900H.P. TRIPLEX-RUNNER WATER TURBINE FOR FALL OF 16FT.

head of water actually to carry a considerable part of the weight of the turbines and the generators at all times. This is done by admitting the water of the flume into a space directly under the second runner of each turbine, where it exerts its pressure upward against a circular plate which forms a revolving-piston. The water will carry about one-third the weight of the rotating parts, and the other two-thirds is carried by a thrust bearing supported by the castings of the turbine.

The runners are of non-corrosive bronze, each cast in one piece. They are fifty-five inches in diameter. Surrounding each runner are the gates which admit the water to it and control its speed. Outside the gates of each runner and reaching all around it so as to admit water to all parts of the periphery of the wheel at once is a space ample for that purpose. The gates are composed of movable guide vanes and so constructed that when open they admit a full head of water with but little interference, and when closed totally exclude the water. They are all connected by links to a common gate ring and arranged so that a minimum of power is required to operate them.

The wheels will each produce 900h.p. with a sixteen-foot head with a consumption of 620 cubic feet of water per second, or 625h.p. at a twelve-foot head with a flow of 650 cubic feet per second. Working at full gate, they are expected to develop seventy-eight per cent. of the power of the water, or more, and to give eighty per cent. return at three-fourths gate. At half gate they are expected to give seventy-five per cent. of the power of the water. The installation is typical of what can be done with low variable falls and should provide material for others of a similar nature where recourse to steam or other power may be under consideration.



Triplex Runners Mounted on Shaft for 900h.p. Water Turbine

Power in Mexican Mines.

Mexico is the natural hunting ground of the miner, but its richness in mineral wealth is discounted by the lack of cheap fuel for power purposes. Mule transport alone is available, and quite frequently weeks elapse between the time a transport leaves the coast and its arrival at the mining centre, or *vice versa*. The mule tramways of the chief Mexican cities were electrified years ago, but not until recently was any attempt made to utilize the hydraulic forces of the country. We have already referred to several of the water-power schemes put into operation, and we understand that others equally important are being put down. Long transmission lines are the order of the day, but this acts as no deterrent to engineers who regard distance as no object.

The Rosa Amarilla copper mines, in the western part of Guadalajara, for years have been recognised as exceedingly rich; but the high cost of transport to the coast handicapped the owners. It is now proposed to construct large power plants on two small rivers near the mines, and to utilise the electricity thus developed both for operating the mine machinery and also for an electric railway to the Pacific port of Navidad.

Another concession for power development for mining, irrigation, and railroad, is that obtained by a company in the State of Jalisco. The inland mountain lake of Chapala holds sufficient water to irrigate 300,000 acres of fertile soil in the valleys below, and to furnish several hundred thousand horse-power for industrial purposes. A power plant is to be constructed on the Santiago river, near by; and transmission lines will run through the richest mining regions in the vicinity.

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Hydraulic Work on Great Power Schemes.

A MODERN hydro-electric power house must appear to the casual visitor the acme of simplicity for the conversion of natural into electrical energy. Could he have inspected the site during building operations he would doubtless have been impressed with the enormity of the task of stemming the rush of mad waters and diverting them into proper channels admitting of their use. The bulk of the cost of up-to-date hydro-electric stations is sunk in impounding the water and conducting it to the generating plant. This latter is now practically standardised and can be installed at remarkably short notice, in fact in many cases both turbines and alternators, transformers and switch-gear are on the ground sometimes weeks and months before the station is ready to receive them.

A notable instance in which considerable work of a civil engineering character has been needed to facilitate the use of a river is that recently carried out at Taylor's Falls on the St. Croix River, Minnesota. Twenty-one miles above the Falls a dam had been constructed for logging purposes, and by building a new dam at the Falls themselves an enormous amount of water can be held in reserve between these two points. The dam is 740ft. long by 50ft. high, and when complete will be 40ft. thick at its base and 10ft. at the top. It is being built entirely of concrete and what is known as trap-rock, and is supported on the solid bed rock of the river. Steam drills, modern blasting facilities, rock crushers, and concrete mixers all have contributed towards the rapid completion of the work, and it is estimated that 500 yards of concrete and crushed rock are laid daily. Steam derricks, tramways, and an aerial ropeway serve for the transportation of the materials between the two banks. A 40ft. automatic trap log sluice-way is being provided in the dam in addition to a fish-way. A canal which will serve to divert the water to the penstocks is to be 30ft. deep by 125ft. wide, cut in solid rock. When the plant is complete eight 14ft. steel penstocks will convey the water to the turbines under an effective head of 55ft. It will be seen that very material difficulties are being encountered in a scheme of this nature, and that although the volume of water is large and practically constant, only after enormous expenditure of time and money on work essentially non-electrical in character can the natural downward flow of the water be put to good purpose. It is this heavy initial cost in what may be termed the civil-engineering portion of such schemes which prevents the adoption of many ambitious proposals for the production of hydro-electrical energy. The initial cost of many of the largest of such undertakings is difficult to obtain information upon, and it may safely be assumed that for stations of equal output a steam plant with modern turbo-generators can compete successfully with the best hydro-electric combination for many years. Until satisfactory figures are put forward as to the expenditure necessary for the impounding of the water and its delivery to the turbines it will be difficult to compare modern steam and water-power plants, but except in the very large schemes the total costs of modern steam stations must be lower than those obtaining with hydro-electric units.

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

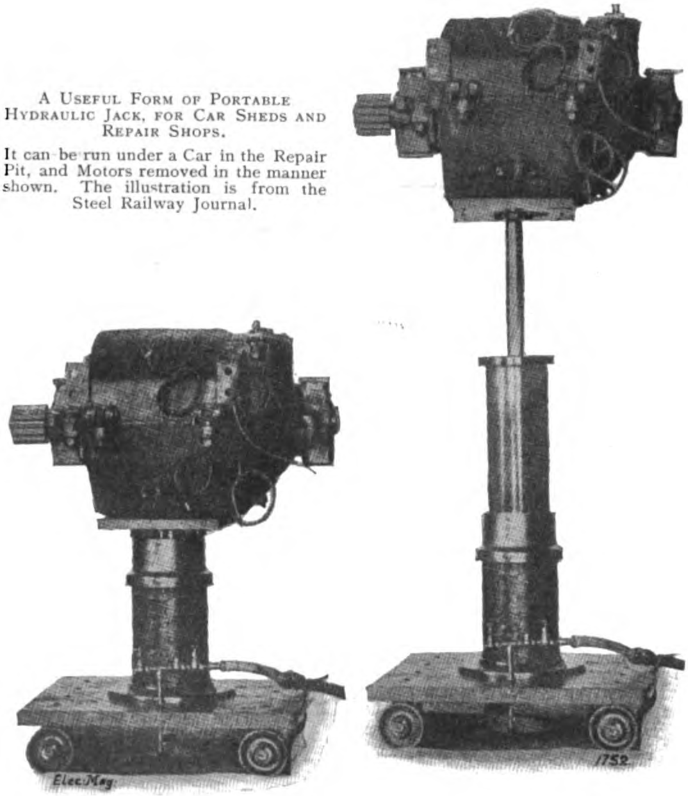
The Effect of Consolidation on the Local Representative.

By WILLIAM PESTELL.

The striking modern tendency of electric railway and lighting companies has been toward consolidation of the controlling interests. The utility of centralisation and specialisation is unquestioned in commercial life of to-day. Its present application to public service corporations, however, is unsatisfactory in some details of practical operation. I do not in the least underestimate the immense advantages it has bestowed, but I believe it is time to call attention to one salient point where friction exists in the machine. In the first place it has gathered into compact groups the highest engineering and executive talent of the country. It has enabled the small properties to employ this talent in supervision of improvement; expense alone, apart from other obstacles, would render this impossible but for perfect organisation. Moreover, by a magnificent system of reports, it makes possible a comparison of the operation of various properties, which, in the case of properties on a poorly-paying basis, is of inestimable benefit.

In the face of such advantages conferred, it is perhaps excusable if any accompanying detriment has been overlooked. Nevertheless it exists. It exists in the local representative and in his relation to the central organisation. Public opinion of a company, an unassailable asset when once established, is, in a public service company, largely based on two things—services rendered and local administration. The average commuter knows little and imagines less of the perfected systems developed to facilitate his transportation. They mean nothing to him. But if his car is ten minutes late on a stormy morning, or if he is unable to get a prompt decision on an apparently trivial matter, he is loud in his denunciations. Public opinion of a company depends no less surely, but in a less degree, upon the employee's opinion, which is based upon the treatment he receives and upon the apparent authority of his local superior. If, in the development of its central organisation, the company has dwarfed or belittled the local organisation by presuming to dictate a hard and fast policy, regardless of local conditions or opinions, as reflected by its representative on the ground, the company is bound to suffer. If the company has curtailed too greatly the authority vested in either its local manager, superintendent, or engineer, it has lost sight of that important factor, the personal element, so necessary in the handling of men, be it its employees or the public. Since the company's reputation depends so greatly upon its local representative, he should be a man carefully selected and should be given authority in accordance with his responsibility. He should be vested with authority to settle on the spot all matters not affecting the general policy, and therefore he should be so thoroughly informed in regard to the general policy as to be able, before rendering a decision, to use judgment in determining the necessity of consulting higher authority.

It may be said that it is impossible to get suitable men for the large number of positions now open. This appears true, as is evidenced by the comparatively large salaries paid to responsible men for the management



A USEFUL FORM OF PORTABLE HYDRAULIC JACK, FOR CAR SHEDS AND REPAIR SHOPS.

It can be run under a Car in the Repair Pit, and Motors removed in the manner shown. The illustration is from the Steel Railway Journal.

of properties at great distances from the central organization. But it is a fact that the present practice of seriously limiting the authority of local representatives is not only spoiling men now in such positions, but is slowly and surely obliterating all possibilities for development of good material. The first requisite of a successful public service corporation manager is a thorough understanding of human nature, and no man can acquire this thorough understanding who is not allowed to think and act for himself in his dealings with other men. And this the "average" local representative is not privileged to do under the present system.

Anyone who has served a modern consolidated company as local representative will fully appreciate the truth and validity of this assertion. Managers and officials of large companies, who have seen scores of apparently able men, the graduates of our colleges and technical schools, make dismal failures when put into responsible local positions, would do well to ascertain whether this relation of utter dependence of the local representative upon the central organization is not the cause of these apparent failures. If it be urged that many such graduates are placed in responsible positions before they have acquired sufficient experience in the handling of men, whether employees or the public, I repeat that the present system is absolutely inadequate, in that it affords such men no opportunity to develop the requisites for successful management, but rather places them in a position of dependence, which ultimately destroys initiative power and firmly shackles the most potent individuality.

The above article from the Street Railway Journal indicates a state of affairs in American electric railway administration which need not be emulated on this side.

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Memorable Traction Correspondence.

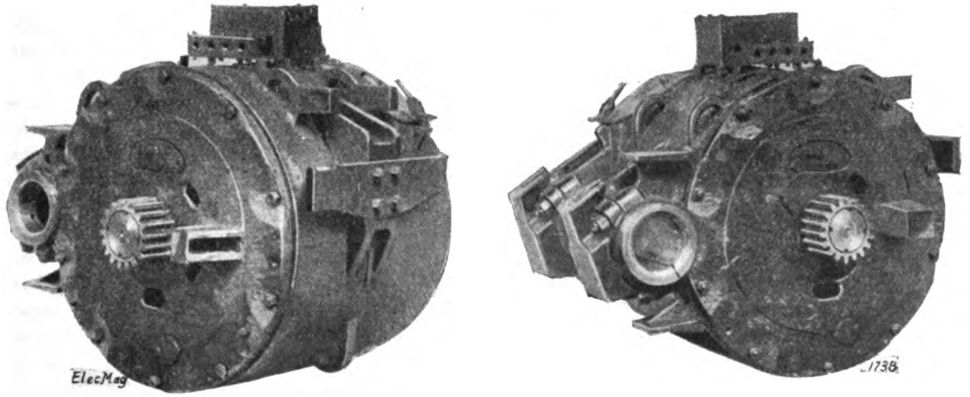
LAST month we referred editorially to letters written by Mr. Westinghouse to the New York Central Railway, pointing out the disadvantages of the direct-current system selected by them for their suburban lines. We give below extracts from his letters, and also introduce matter in reply from Mr. F. J. Sprague, which bears directly on the subject. The letter of Mr. Westinghouse is addressed to the President of the New York Central, and its opening passages contain the following:

"The business relations existing between your company and those I represent, and the consideration you and your officials have always given my personal views on the subject of the electrification of your railway, seem to demand the prompt fulfilment of my recent promise to set out to you in a letter the reasons why, because of the possible much greater use of electricity upon many of your lines of railway, your company could and should now change your plans providing for the use of the continuous-current, third-rail equipment, to those employing the single-phase overhead system.

"Bearing upon these are the comparative costs of the line equipment of the two systems. As an example, the comparative cost of line and sub-station installation for single-phase and direct current to meet the conditions of traffic now existing on the section of the New York, New Haven, and Hartford Railway from Woodlawn to Stamford, based on the following:

"(a) Single-phase, high-tension transmission, transformer sub-stations, 6000 volt overhead line supported by catenary construction from bridges spanning four tracks.

"(b) Direct current employing high-tension alternating-current transmission, rotary converter sub-stations and third rail at 600 volts.



Two Views of the One-phase Motors which will be used on the St. Clair Tunnel Locomotives. (See page 101.)

Comparative Cost per Mile of Four-track Line.

		Single-Phase	Direct-Current.
Sub-stations	..	$1,714	$16,150
Contact line	..	12,436	18,872
Transmission line	..	1,815	2,181
Track bonding	..	308	308
		$16,273	$37,511

Difference per mile in favour of single-phase, $21,238.

Comparative Cost per Mile of Double-track Line.

		Single-Phase	Direct-Current.
Sub-stations	..	$1,542	$13,840
Contact line	..	6,750	9,436
Transmission line	..	1,815	2,181
Track bonding	..	154	154
		$10,261	$25,611

Difference per mile in favour of single-phase, $15,350.

"These figures mean, assuming that your company may in the near future electrify its main lines from New York to Buffalo, that the extra cost of the line equipment with the continuous-current system for 450 miles of four-track road of the New York Central main line would amount to $9,000,000, and for the double-track of the West Shore road, $6,750,000.

"Stated briefly, your situation seems to be this: Your power house and its equipment now under construction is suitable, without substantial change, as are also your sub-station rotaries and storage batteries, for the operation of single-phase equipment. Orders have been placed for 35 electric locomotives, costing, say, $900,000 and 180 electric car equipments with multiple-unit control, involving an additional $775,000. Neither the locomotives nor the cars and equipments will be needed before September of next year (1906) according to your present desires, but most probably not before April in the year following, because of the inevitable delays in the carrying out of so important a work as you now have in hand.

"You know of the diametrically opposed views and interests of the Westinghouse and General companies, and of the strife between them. The greatest difficulty in arriving at a conclusion is likely to be due to the commercial rivalry between the two electric companies, but there seems to be no good reason why your company should be a victim of such commercial strife. I feel confident that my recommendation that you now take steps to effect the change from your present plans will be found to be based upon the best of reasons, and that that recommendation will in all probability prevail if the matter is most carefully investigated, as I am sure it will be.'

Mr. Westinghouse circulated this letter among the American technical journals, and in writing to the Railroad Gazette he sent a further letter which touches on the interests allied against one-phase methods. Collectively nor individually he spares none of his opponents, and the old zeal which fired him in the eighties now burns up afresh with unabated strength. He says: "The triumphant success of the alternating current system, without which none of our great railroads could have had the benefit of electric traction, needs no words of mine to emphasize it; but there are arrayed to-day against the alternating-current single-phase system of electric traction many of the same men and the same interests, actuated by the same commercial spirit and using the same methods and tactics as were employed by them in the days referred to when they began their 'peculiar' opposition to the alternating electric system.

"In 1886 it was said by some influential people that I was making a mistake in attaching so much importance to the efforts being made at that time to discredit the alternating system. The beneficial results which have followed my efforts in that and other cases, in the true interests of users of electric apparatus, impel me to believe that I would be remiss at this moment to accede to like suggestions which have been recently made to me.

"Mr. Sprague, while disclaiming that he was speaking officially for the New York Central Company, seems to have left no doubt in the minds of a large number of people that his views were those of the members of the New York Central Electrical Commission. In his haste to create for his clients a strong public opinion calculated to induce the officials of the New York and New Haven Railroad to give up their plan to use the single-phase alternating system and to take exactly the same kind of apparatus as the New York Central had already contracted for, namely, the third-rail direct-current system, and in pleading the great need for uniformity, Mr. Sprague forgot to inform the public, probably as he would have done had he had more time, that he is receiving a very large retainer under a contract of years' duration, whereby, though he may become consulting engineer for a railroad, yet he cannot do so if, in the opinion of the officials of the General Electric Company, such work or obligation may be in conflict with the interests of that company; and having a particular personal interest in his own form of control, which is suitable for direct currents only, he equally overlooked the fact that the electro-pneumatic multiple-unit control made by the Westinghouse Company had been fully perfected for the operation of locomotives and multiple-unit trains when operated by the alternating single-phase or the direct-current."

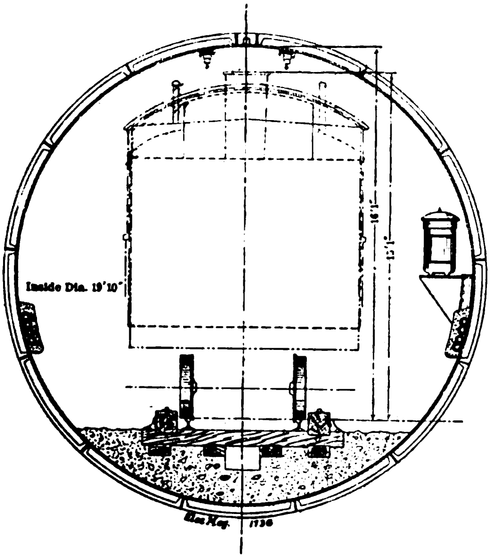
Mr. Sprague naturally did not take this lying down, and in the course of a long disclaimer at the action of Mr. Westinghouse says:

"The charge that the General Electric Company and myself are engaged in a conspiracy to fasten upon the railway world the direct-current system as opposed to the alternating-current or any other particular system unduly enhances my importance, and is an amusing product of imagination, or the result of hysteria. I must remind you that I was probably the first engineer in this country to recommend, in an official report some fifteen years ago, the general adoption of alternating current for the transmission of power over long distances, and I have not changed my attitude since. I have also to call your attention to the fact that not only have I steadily advocated higher potentials, but several years ago I publicly expressed the desirability of the development of single-phase motors for use on electric railways. And in order that you may not, unchallenged, appropriate to yourself all initiation in this art, I must not forget to mention the late lamented Charles Van Depoele, whose name you may be familiar with, who, in addition to much other admirable pioneer work, some sixteen years ago advocated and patented a method of using single-phase currents on electric railways.

"Your attack on me is misjudged, and is unworthy of your own dignity, for even if your personal qualities do not appeal to the softer side of my nature, and your assumptions do not always carry conviction, I still recognise in you many elements of greatness. It will therefore fail in its purpose, for it will not cost me a single friendship, and will not impair the confidence of my associates, nor do I believe it will adversely impress any fair-minded man, though he be a stranger to me. I will go further—it will not affect my appreciation of the many splendid products, or affect my final judgment concerning any developments or proposals of the Westinghouse Company, which will live on even after your dominant personality in its affairs disappears.

"Permit me in conclusion to remind you that my work and inventions have been among the stepping-stones to your great fortune, and while others and not I have reaped the larger material rewards of that pioneer work, I have at least succeeded in impressing my name upon the electric railway development in such indelible fashion that you cannot erase it. It has never stood for doubt, or cowardice, or fear of consequences, but always for advancement—in which in many important particulars you have followed, not led me. My engineering convictions and conclusions are my own. They are dictated by no man or corporation. I am not the advocate of the use of any particular system to the exclusion of any other, but rather of higher potentials and the greatest measure of development by whatever means—for such system as in any particular case shall, when measured by all conditions of equipment and operation, best fulfil the requirements of that case.

"That attitude is one which I shall consistently maintain, unchanged by clamour, pressure or disapproval, and so long as I am given life and strength, and retain the confidence of my associates, I shall help carry to success the enterprise which you have so freely criticised, and thus aid in planting another milestone to mark the advance of electrical accomplishment.



Section through St. Clair Tunnel showing Outline of Steam Locomotive and Car.

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Electric Traction in Tunnels.

The frequent recurrence of accidents in tunnels plying steam trains a few years ago, directed attention to the importance of ridding all long tunnels of the smoke and smell attendant upon such locomotive service. Accidents could be traced to the obscuring the signals and the track ahead, thereby depriving the driver of adequate control over his train. The electrification of the New York Central is the direct outcome of an accident involving heavy loss of life. The Park tunnel in which this occurred was alone to be electrified, but a complete conversion from steam was recommended for the entire suburban stretches of the line.

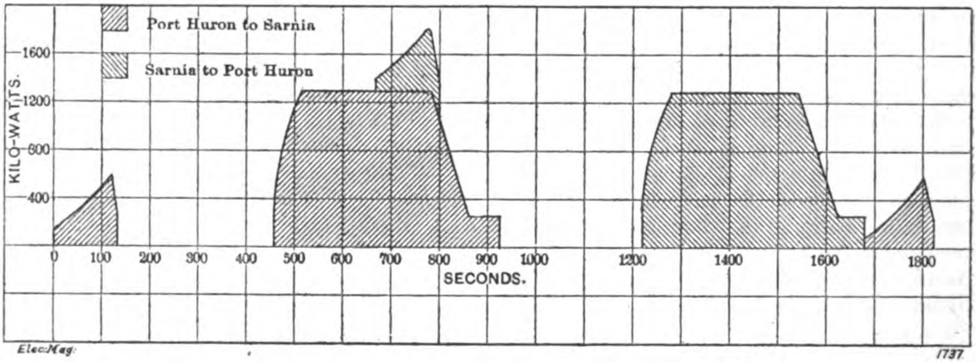
Tunnels have always been the *bête noir* of railways, and the longer examples have never been free from smoke even with the constant operation of a ventilating system. In special cases it is quite feasible to install an electric power plant and run the service of trains by electric locomotives, the same coaches being used through the tunnels. The Simplon tunnel, recently opened, will be equipped for three-phase traction, and now particulars are to hand of a scheme for one-phase working by locomotives of the Grand Trunk Railway service through the St. Clair River tunnel connecting the American and Canadian divisions of the system.

The locomotive adopted will weigh approximately 62 tons, and will develop a drawbar pull of 25,000lbs. on a 2 per cent. grade at a speed of 10 miles an hour. It is of the rigid frame type with driving axle boxes held in the same frame that contains the draft gear.

A motor will be geared to each axle, giving each unit an aggregate rated capacity of 750h.p. The motors are of the series-wound, compensating type, of the same general character as those selected by the New York, New Haven and Hartford for the operation of the line between New Haven and New York. Each motor will weigh complete approximately 14,500lbs., the armature weighing approximately 5600lbs. Within the motor frame is built up a core of soft steel punchings, forming a completely laminated field.

The field coils are wound with copper strap insulated between turns, and about the coils by mica, and finished by taping and dipping, and are impregnated in the best grade of varnishes, providing a sealed coil which can withstand the most severe internal heat and is practically indestructible under the usual conditions of heavy railroad service.

In addition to the main coils the field carries a neutralizing winding which consists of copper bars placed in slots in the pole faces and joined at the ends by connectors of copper strap, so as to form one continuous winding which is connected in series with the main field winding and with the armature circuit. The magnetising effect of this auxiliary winding is directly opposite to and neutralises that of the armature winding, thus eliminating the effect of armature reaction and improving commutation and power factor. The main coils can be easily removed without disturbing the auxiliary winding. A preventive winding on the armature is connected between the commutator and the main coils, introducing a preventive action which is effective only when the coil is passing under the brush.



Load Curves Calculated from Computed Data for One-phase Locomotives to Operate in the St. Clair Tunnel.

A forced circulation of air supplied by motor-driven blowers enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation of both motors and auxiliary apparatus forms one of the most interesting innovations in electric railroad construction. It secures a maximum output from a given weight of material, and a high ratio of continuous output to the one-hour motor rating common in railroad practice.

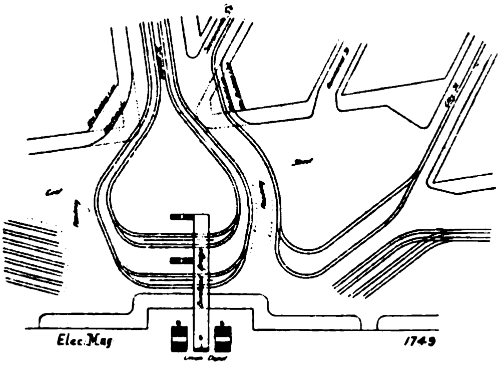
For the operation of the electric locomotives a complete power plant will be installed, including two 1250kw., 3300-volt, 3-phase, 25-cycle, rotating field, steam turbine units running at 1500r.p.m. This station will also supply current to light the buildings, yards and tunnel, to operate motor-driven centrifugal and triplex pumps which drain the tunnel and approaches and operate the sewage systems, to run motors in the roundhouses, and for other purposes.

The St. Clair river tunnel proper is 6032ft. long and the line to be electrically operated is 19,348ft. from terminal to terminal.

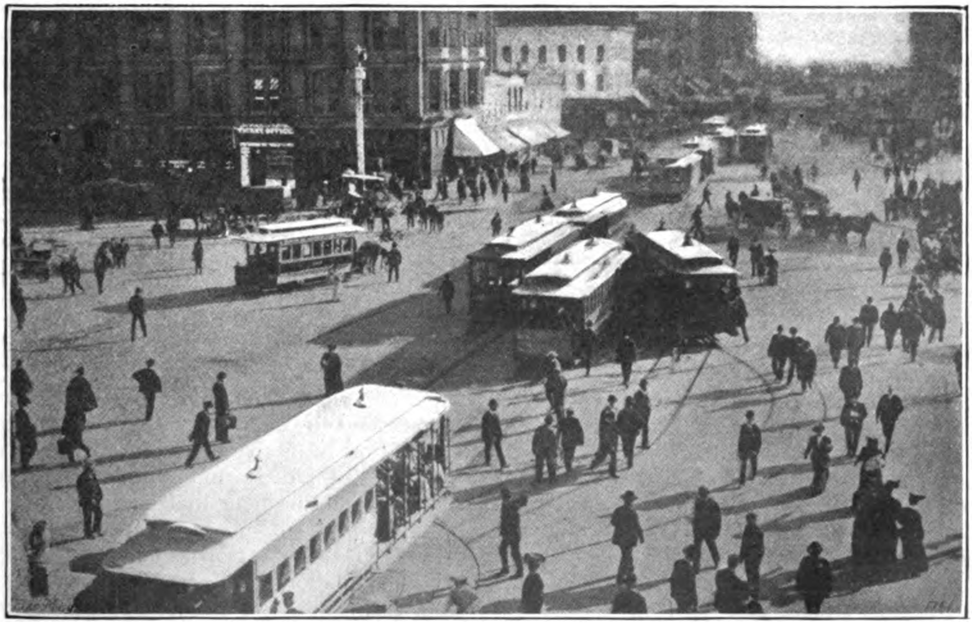
A pair of the new units will be capable of hauling a 1000-ton train through the tunnel without division. The service requires that each unit shall take a train of 500 tons from summit to summit in 15 minutes under the following conditions: It must accelerate to a speed of twelve miles an hour in two minutes, at the end of which time it will have reached the summit of the grade leading down into the tunnel. It will then run down a 2 per cent. grade to the level track in the tunnel at a speed not exceeding twenty-five miles an hour, continue on the practically level stretch under the river, and then draw the train up a 2 per cent. grade at the rate of ten miles an hour to the level track beyond the tunnel approach on the other side. It must then gradually accelerate the train until a speed of eighteen miles an hour is reached. Six locomotives are to be furnished, and the equipment will greatly relieve the traffic congestion now due to the necessity of dividing trains at the terminal points. Its opening will mark the progress of electrical methods in the railroad field under conditions which seem peculiarly fitted to demonstrate its practical advantages in heavy service.

San Francisco's Traffic Problem.

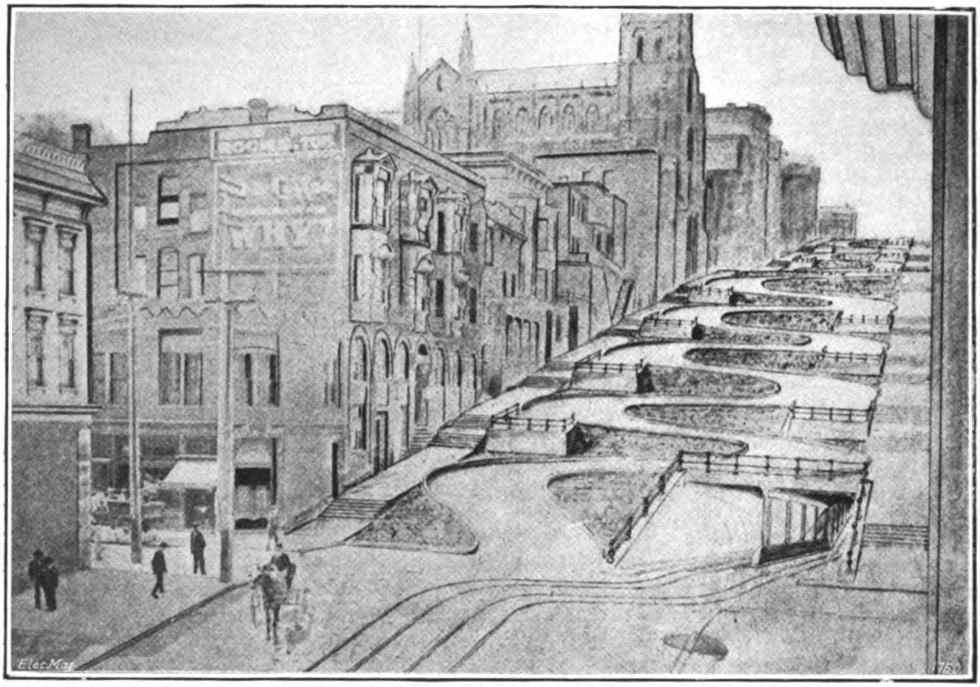
THE transit facilities of San Francisco are at present chiefly confined to a service of electric, steam, cable, and horse trams, which bring down on themselves the anathemas of residents, and disgrace all modern ideas of city and suburban transport. Mr. William Barclay Parsons has just issued a report, prepared at the request of the San Francisco Merchants' Association, in which he embodies the results of a study of the city's street railways, and recommends a whole-hearted adoption of electric trolley traction. The city had a population of nearly 450,000 in 1905, and was provided with about 288 miles of tramway track operated by four companies. The systems comprised 204 miles electric, 77 miles cable, six miles horse, and one mile steam. These carry an aggregate of 153,970,000 passengers per annum, but through facilities are so poor that 41,700 transfers have been issued during a year. For the unification of these systems, Mr. Parsons, in the course of his report, quotes the recommendations of the London Traffic Commission, in which it will be remembered electric trolley trams were given preference over conduits and surface contacts. He strongly advises San Francisco to consolidate on the uniform trolley, and no other. The accompanying illustrations are taken from the report, which contained many interesting photographs and plans. The congestion of cable cars in Market Street will be noticed from the view of that thoroughfare, and the diagram of loops suggested to relieve it embodies the results of some careful scheming. The use of a bridge as a feeder to the centre of the loop is decidedly novel, and might be followed



PROPOSED LOOP FOR MARKET STREET LINES IN SAN FRANCISCO.



THE PRESENT CONGESTED STATE OF CABLE CAR TRAFFIC IS MARKED IN SAN FRANCISCO. A TURNTABLE IS EMPLOYED TO CHANGE THE CARS FROM INCOMING TO OUTGOING TRACKS.



Perspective View of Terraced Street in San Francisco Hill District
This construction is proposed to relieve the cars of hill climbing and admit of their passage through the hill in a subway.

with advantage in similar cases. The loop system has only been applied to the single main artery, as the "stub ends" of the other tracks are found to be satisfactory at present. Market Street it appears serves an important ferry, and congestion usually occurs in the morning and evening rushes—when five to eight cars are blocked at a time, and passengers alight to finish the journey on foot.

The line of several main routes in San Francisco is crossed by steep hills, which impede traffic and occasion delays. Mr. Parsons suggests that these hills be tunnelled through, and that the roadway be terraced and laid out with gardens. Our illustration, also taken from the report, will make this clear. Referring to the essential requirements of good service, Mr. Parsons says:

"The maximum efficiency is rendered by a transportation system when the methods of operation are reduced to the simplest form with absolute uniformity. It is obvious that the greatest convenience to the public will have been realized when a passenger can take a car at any point and go to his destination on the same car without the annoyance and delay of transferring.

"In the present state of the art of transportation, electricity is the most satisfactory means of applying power; it is clean, elastic, capable of producing high speed, easily controlled and economical. Steam as a power should not be permitted within a city's limits; horses are thoroughly inefficient; while the cable lacks elasticity and is defective in speed. The unfortunate street gradients of San Francisco have apparently demanded the continued use of the cable, although it has been abandoned in other cities. Horses and steam can be easily removed; and they should be removed promptly. The cables are not as necessary as they have appeared to be, and they, too, can be made to give way to a superior form of operation. I shall therefore recommend to your Association the abolition of all forms of motive power except electricity as the most radical and fundamentally far-reaching improvement that can be made to your local system."

There is every reason to believe that these recommendations will be closely followed and, as a result, San Francisco will be raised from antediluvian levels to those of modern civic life with benefit to all concerned.

Central Station Practice

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

The Principles and Practice of Mechanical Stoking.

By W. H. BOOTH.

THE stoking of a steam boiler is one of those duties that is sufficiently disagreeable to produce a desire to have the operation performed mechanically irrespective of the question of mere labour saving. At the same time labour saving is at the bottom of the latest modern methods to such an extent that it is likely that in frequent instances more is spent upon coal than is saved in labour, owing to the extreme imperfection of so many machine stokers.

Not many years ago, however much the makers of machine stokers may have made professions of saving labour, they entirely misapprehended the problem before them. The height of the boiler grate from the floor line was rarely more than one-half that of the coal hopper into which the coal still required to be shovelled by the unfortunate stoker. His labour in actual foot pounds of work done was doubled. Further, the easiest way of filling the hopper was by overshouldering the shovel backwards. The lighter dust was winnowed out of the coal as it passed from the shovel to the hopper. This dust was deposited over everything, not omitting the man himself, and there was no open fire door to draw away the dust-laden air, so that the last end of that man was worse than the first, and no boiler houses were so filthy as those where the stoking was done by machinery which it was a farce to call labour saving. The result was that mechanical stokers were very properly condemned by the men whose labour was increased, and who went home dirt-begrimed from head to foot.

The mechanical feeding of the hoppers came later, and it did not come because the above difficulty was properly appreciated, but rather because, in large modern stations, the difficulty of getting coal to the boilers became so great that mechanical conveyors became a necessity. The mechanical filling of hoppers gave to the stoking machine an opportunity of showing what it could do, for the hostility of the fireman was assuaged. But until that time it was a stupid blunder to spend time and money on labour-saving machines which did not even at the outset save labour, and only served to destroy the proper pride of the fireman in the cleanly and bright appearance of his boilers, not to mention his own personal comfort and cleanliness.

In considering therefore the subject of mechanical stoking it can only be approached as a homogeneous whole, and in brief one may lay down the ideal conditions that from coming into the yard as coal to going out therefrom as ash or clinker the manual labour expended on fuel must be a minimum. Granting these conditions the question of stoking may be considered in respect of its advantages or the reverse. In order adequately to understand the subject it is first necessary to know what it is that the machine stoker is to supersede, the faults that by avoiding, the machine stoker may gain an advantage, and the intelligence which no machine can exercise, the absence of which makes hand-firing so hard to beat in coal economy.

To begin with, coal is burned under steam boilers in order that steam may be produced within them. But to effect the maximum of steam production with the minimum of fuel it is necessary that the calorific capacity of the fuel should be fully developed, that the products of combustion should be the minimum consistent with this development, and that they should be of such a nature as to preserve the heat transmission surfaces of the boiler in their highest condition. By securing the three conditions named it will be secured that the full value of the fuel will be applied at the highest temperature to clean surfaces. A full consideration of these things would lead to many points which, fully to investigate, would extend to too great a length. Sufficient for the moment to take things as existent and aim to secure the named conditions of smokeless combustion with a minimum of air.

In firing by hand the stoker who is really skilful does not put upon the fire at one time very much fresh fuel, and when he does add fuel he deposits it on or over the thinnest parts of the fire, so that the whole fire may be maintained of even thickness. If not sufficiently skilful to carry out this practice as fully as he would wish he must use a rake or spreader, with which he levels the fire *surface.* He does not allow the rake to sink into the body of the fire, but causes it simply to push the crests of the hills into the valley by a light quick stroke occupying a minimum of time. This brings forward a point of particular importance. When the furnace door is open an excessive volume of air flows in and chills the whole boiler. To prevent this fault, which occurs every time the firedoor is opened for any purpose whatever, is one of the objects of machine stoking. There are machine stokers, however, which spread the coal upon the surface of the fire and sometimes fail to do this evenly. The inability of the machine stoker to see and to think is then made evident by the persistence with which it continues to send too much fuel to one particular spot in the furnace, where a hill is kept in continual formation and must as constantly be levelled by the rake of the attendant. This necessitates the opening of the furnace door, and to such an extent as this becomes necessary does such a machine fail in eliminating the faults of hand firing.

There are other methods of hand firing than that of spreading the fresh fuel over the fire surface. In the coking system, the green fuel is placed on the dead plate where it parts with its gases under the effect of heat radiated from the fire and from the brick arch over the dead plate. When the coal has parted with its gas the door is opened and the coked mass is pushed back by the rake and rapidly spread over the fire surface, a fresh heap of coal being then placed to coke on the dead plate. This system is the best, on account of smokelessness, and it is copied in many mechanical stokers which feed the coal upon the dead plate and cause it to creep forward upon the grate by means of a peculiar creeping movement of the bars.

In another system of hand firing the coal is alternately spread upon the full length of either side of the fire, leaving the other side bright and red. This aid to smokeless combustion is copied in some stoking machines which act on the sprinkling system, and sprinkle coal alternately along each half of the furnace in turn. The foregoing hand methods are all copied or followed more or less closely in mechanical methods, the endeavour being made to preserve an even fire thickness, a regular draught, a constant and continuously regular feed of coal, and a uniform supply of air, in order that the régime of the furnace may be constant and the efficiency may be maintained at a maximum. But the dirt or incombustible matter in coal puts an effective stop to such endeavours when such matter is fusible, as almost always it is, for the mineral matter fuses upon the bars, and even when these move to and fro, side by side, the clinker chokes the air spaces, and it becomes necessary to clean the grate. The necessity of cleaning the grate as in hand firing has given rise to self-cleaning grates.

In a hand-fired grate cleaning is effected by moving the fire to one side of the grate, thus laying bare the fused layer upon half the bars. Deprived of its hot covering this layer cools rapidly by radiation to the boiler and by the passage through its few openings of air from below, and also by contact with the grate bars, which become cool by radiation to the ash pit and contact with the air below. Clinker, which when hot is soft and tenacious, like semi-molten glass, cools to a brittle substance not unlike a dirty black coarse glass in some cases. It is then easily separated from the grate and raked out, the clean side of the grate now receiving the fire while the other side is cooled off and cleaned.

A skilful man may add a little fresh fuel upon the cleaned part of the grate before he replaces the incandescent fuel. This added fuel provides gas to use some of the excessive volume of air coming in at the bare parts of the grate. Needless to say, during cleaning the draught is minimised by closing the dampers so as to minimise the cooling effect of excessive air supply.

All stokers with moving grates possess some self-cleaning property, but few are wholly and continuously self-cleaning. The difficulty with all so-called automatically cleaning grates is that the clinker is so soft and tenacious that it adheres to the bars, will not break, but will yield and bend with bars that may be given a large movement without breaking the clinker, and it is, therefore, not readily movable without the chill that is necessary to cool it to the brittle stage, in which it may be broken up by rocking bars, or by the rake. Without the coaling process clinker cannot be dealt with after it has fluxed on the bars into a thin continuous sheet.

Bearing these facts in mind various forms of mechanical stokers may be studied in order to find from such study how far they have met the requirements which the human stoker endeavours to fill; where they fail and why, and what errors they introduce additional upon faults known to appertain to hand firing.

The sprinkling stoker is constructed in three forms as regards the sprinkling apparatus. Coal from a hopper above is fed through toothed rollers upon a rapidly revolving fan below, which turns on a horizontal axis, and throws the coal over the whole surface of the fire. The form of the plate in front of the fan determines more or less the spread of the fuel, but there is a tendency for the heavier pieces to fly to the greater distance. In another form, two fan wheels on vertical axes do the throwing, and are probably better distributors, but the more usual method is by spring and camb-actuated shovels so arranged as to vary their sharpness of release in order better to distribute the fuel. It is usually considered that this type of stoker will get more work out of a boiler than can be got by a coker machine and, where the conditions of a boiler are such as to produce smoke, this type of machine will produce a light grey smoke continuously, so that in the aggregate it produces a large volume of smoke per day, though so evenly distributed throughout the whole time that it does not appear sufficient to complain of. Recognising the difficulty of feeding regularly over the fire surface, one maker threw all the coal against the bridge, whence it was brought slowly forward by a chain grate. This machine was really a coking machine, for the front of the fire was purely red coked fuel and the green coal was coked near the bridge. The reason why this stoker was abandoned was that, as with all machines using dry coal, the dust was winnowed out by the draft and carried into the flues and out at the chimney to cause a nuisance. This common fault of all machine sprinklers condemned it. It had also faults peculiar to the chain grate which will come into notice later. But it was otherwise an excellent machine, and delivered its dirt and ash and clinker into a basket in front, and the grate was self-cleaning of the clinker, which cooled off and became brittle as the chain bent over the outer roller.

In the ordinary sprinkler machine the grate is stationary and becomes dirty, and must be cleaned exactly as in hand firing. After cleaning, the red coke which remains must be spread over the grate and the sprinkling gear restarted. A little hand firing is sometimes resorted to to get up the fires to a fair thickness sooner than can be done by the machine itself. Attention is required to regulate the draft to suit the clean or dirty state of the fires. Provision of air to combine with the gases driven off the green fuel does not seem to be seriously attended to in these machines, but, as a fact, air leaks in in fair quantity, and through one unexpected way, viz., the coal in the hopper, for this is porous and loose, and doubtless admits a fair quantity of air through its many interstices. In hand firing the openings for air are large, measuring, perhaps, four square inches per square foot of grate. In a ton of bituminous coal there are some ten thousand cubic feet of gas, and in a single stoking of 56lb. there are thus 250 cubic feet of gas given off in the course of two or three minutes, and this gas will require probably 2500 cubic feet of air to burn it, if not more according to the relative proportions of CH_4, C_2H_2, or other hydrocarbons of which it consists.

At a velocity of 35ft. per second, or say 2100ft. per minute for three minutes, the area through the door grids must be of an average of about $\frac{2}{5}$ of a square foot for $\frac{2 \times 2100 \times 3}{5 \times 2500} = \frac{12{,}600}{12{,}500}$ or nearly unity. Now $\frac{2}{5}$ of a square foot is, say, 60 square inches, and this represents 3 square inches per foot of a grate of 20 square feet in which about 56lb. of coal would be hand fired at one time. In hand firing the area is made about a third larger to suit the maximum rate of gas distillation, and the openings should then gradually close to zero. In machine firing the gas is always pouring off in a steady stream, and a much smaller flow of air constantly supplied is ample. Thus, in the grate named, at 25lb. per square foot per hour of coal burned the gas output from 500lb. of coal will be about 2250 cubic feet; demanding it may be 22,500 cubic feet of air per hour, or only 375 cubic feet per minute, which at the velocity of 35ft. per second would flow through an opening of only 24 square inches always open. There is always some excess of air coming in at the grate itself, and in the best work the total of air is hardly ever below 150 per cent. of the chemical minimum required by the fuel.

(*To be concluded.*)

Power Plant Economics.

FROM time to time the design and economic operation of central stations come up for consideration before technical societies, and needless to say they form excellent subjects for a discussion. Mr. Patchell's recent paper before the Institution is an admirable example, and the 1903-4 session produced Messrs. Merz & McClellan's

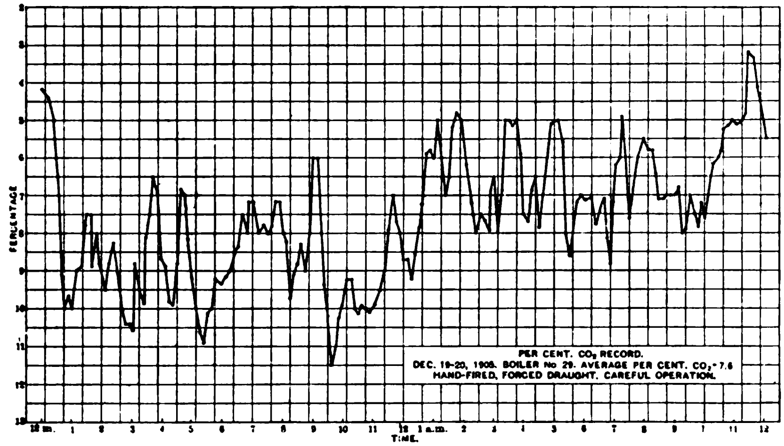


FIG. 1. CO_2 RECORD FROM HAND STOKING.

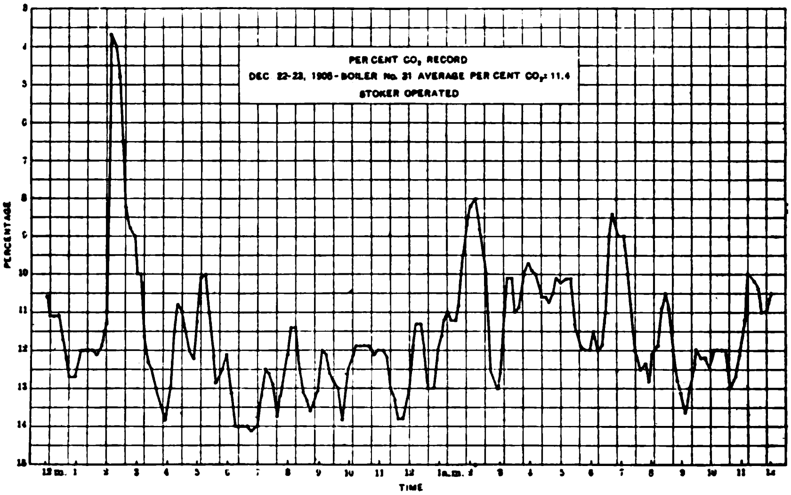


FIG. 2. CO_2 RECORD FROM MECHANICAL STOKING.

paper, which can also be reckoned among those which extract more from an audience than yards of professional rhetoric or blackboards of formulæ. A valuable addition to this sparse list of "drawing" papers is now to hand from the American Institute of Electrical Engineers and is from the pen of Mr. H. G. Stott. He weighs the problem up at all points and does not merely deal with a special aspect of it. He directs attention to what he terms the "basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyse the entire plant from the coal to the 'bus bars: first, in regard to efficiency; secondly, to the effect of load factor upon investment; and thirdly, to the effect of the first and second upon the total cost of producing the kilowatt hour, which is the ultimate test of the skill of the designer and operator." The paper proceeds to analyse the problem from all these points, and a useful table is given, which is herewith reproduced :—

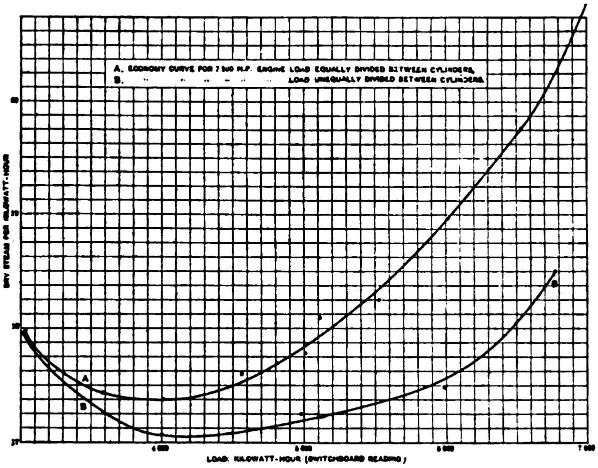


FIG. 3. TYPICAL CURVES, SHOWING EFFICIENCY OF A TRIPLE EXPANSION ENGINE UNDER VARIOUS LOADS.

Analysis of the Average Losses in the Conversion of One Pound of Coal into Electricity.

	—	B.T.U.	Per cent.	B.T.U.	Per cent.
1	B.T.U. per pound of coal supplied	14,150	100.0	—	
2	Loss in ashes	—	—	340	2.4
3	Loss to stack	—	—	3,212	22.7
4	Loss in boiler radiation and leakage.........	—	—	1,131	8.0
5	Returned by feed-water heater	441	3.1	—	—
6	Returned by economizer	960	6.8	—	—
7	Loss in pipe radiation ..	—	—	28	0.2
8	Delivered to circulator ..	—	—	223	1.6
9	Delivered to feed-pump	—	—	203	1.4
10	Loss in leakage and high-pressure drips........	—	—	152	1.1
11	Delivered to small auxiliaries	—	—	51	0.4
12	Heating	—	—	31	0.2
13	Loss in engine friction ..	—	—	111	0.8
14	Electrical losses	—	—	36	0.3
15	Engine radiation losses..	—	—	28	0.2
16	Rejected to condenser ..	—	—	8,524	60.1
17	To house auxiliaries	—	—	29	0.2
		15,551 14,099	109.9 99.6	14,099	99.6
	Delivered to 'bus-bar..	1,452	10.3		

Each of these items is then separately dissected and examined, the results being accompanied by curves from which we have selected four representative examples. These compare the CO^2 records of hand and stoker operated boilers (Figs. 1 and 2) and also the economics of reciprocating and turbine engines (Figs. 3 and 4). With reference to the former and the use of the CO^2 recorder, Mr. Stott claims, and rightly, that the employment of this instrument will admit of the reduction of the stack losses cited at 22.7 per cent. to 12.7 per cent., and possibly to 10 per cent. Referring to item 16, representing a loss of some 60·1 per cent., the author says : "This immediately introduces the thermodynamics of the steam engine, a subject so broad that it will be impossible to do more than touch upon some of the most important points in considering steam-engine efficiency.

"The efficiency of any heat engine can be expressed by the ratio of $E = \frac{T_1 - T_2}{T_1}$ where T_1 is the absolute temperature of the steam entering the engine and T_2 the absolute temperature of the steam leaving the engine. Thus in the engine whose steam-consumption curve is given in Fig. 3, if the initial pressure is 175lb. gauge and the vacuum at the low-pressure exhaust nozzle is 28in., then the maximum thermal efficiency is $\frac{837 - 560}{837} = 33$ per cent. This would be true for any form of engine or turbine working between the same temperature limits.

"In Fig. 3, however, it is seen that the point of maximum economy shows a steam consumption of approximately 17lb. per kilowatt-hour, which is equivalent to 20,349 B.T.U. per hour. One kilowatt-hour is equal to 3412 B.T.U. per hour, so that the actual efficiency of the steam engine and generator is $= \frac{3412}{20,349} = 16.7$ per cent. As the generator efficiency at this load is approximately 98 per cent. the net engine thermodynamic efficiency is $\frac{16.7}{0.98} = 17$ per cent.

"The difference between the theoretical efficiency and the actual is then $33 - 17 = 16$ per cent., of which 6.35 per cent. has already been accounted for in engine friction, so that the balance of 9.65 per cent. is due to cylinder condensation, incomplete expansion, and radiation. As the engine friction in a two-bearing engine with high-pressure poppet valves and low-pressure Corliss valves has by careful design been reduced to less than 6.5 per cent., gain cannot be expected here, so attention must be centred on the loss due to cylinder consideration, &c., amounting to 9.65 per cent., in order to effect any improvement.

"Superheated steam is the only remedy at hand, and with it we can probably effect an improvement of 5 or 6 per cent. by using such a degree of superheat in the boilers that dry steam will be had at the point of cut-off in the low-pressure cylinder. Any greater amount of superheat than this will merely result in loss to the condenser; for it should be remembered that the cylinder losses increase with the difference in temperature between the steam and exhaust portions of the cycle; in other words, the greater the thermal range of temperature, the greater the condensation loss. This would seem to point to the use of more cylinders; but this involves additional first cost and friction as well as more space and higher maintenance charges.

Summary of Analysis of Heat Balance.

"The present type of power plant using reciprocating engines can be improved in efficiency as follows:—

	Per cent.
Reduction of stack losses . . .	12
Reduction in boiler radiation and leakage	5
Reduction in engine losses by the use of superheat	6

resulting in a net increase of thermal efficiency of the entire plant of 4.14 per cent., and bringing up the total thermal efficiency from 10.3 per cent. to 14.44 per cent.

"A typical economy curve of a steam turbine is shown in Fig. 4. An inspection of this curve, which represents what is probably the best results obtained up to date, shows: first, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine in Fig. 3; secondly, that 200 degrees superheat reduces the steam consumption 13.5 per cent. But calculating the total heat units in superheat from $H_1 = H + 0.48\ (t_2 - t_1)$ the B.T.U. per kilowatt-hour are 20,349 for dry saturated steam, whilst for 200 degrees superheat they are 19,008 or a net thermal saving of 6.6 per cent. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo-unit would be considerably better than that of the reciprocating engine, with the other great advantage of costing approximately 33 per cent. less for the combined steam motor and electric generator.

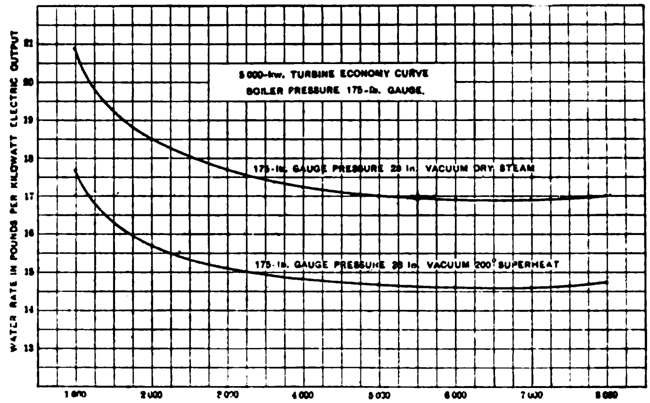


Fig. 4. Efficiency Curves of 5000kw. Steam Turbine, showing the Improvement effected by Superheating.

"The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke, as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high-pressure where relatively it is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

"In the following table will be found the relative values of the various items necessary in the maintenance and operation of a power plant.

Distribution of Maintenance and Operation. Charges per Kilowatt-Hour.

—	Reciprocating Engines.	Steam Turbines.	Reciprocating Engines and Steam Turbines.	Gas Engine Plant.	Gas Engines and Steam Turbines
MAINTENANCB.					
1. Engine room mechanical	2.57	0.51	1.54	2.57	1.54
2. Boiler room or producer room	4.61	4 30	3.52	1.15	1.95
3. Coal- and ash-handling apparatus	0.58	0.54	0.44	0.29	0.29
4. Electrical apparatus....	1.12	1.12	1.12	1.12	1.12
OPERATION.					
5. Coal- and ash-handling labour	2.26	2.11	1.74	1.13	1.13
6. Removal of ashes	1.06	0.94	0.80	0.53	0.53
7. Dock rental............	0.74	0.74	0.74	0.74	0.74
8. Boiler room labour	7.15	6.68	5.46	1.79	3.03
9. Boiler room oil, waste, &c..................	0.17	0.17	0.17	0.17	0.17
10. Coal	61.30	57.30	46.87	26.31	25.77
11. Water	7.14	0.71	5.46	3.57	2.14
12. Engine room mechanical labour	6.71	1.35	4.03	6.71	4.03
13. Lubrication	1.77	0.35	1.01	1.77	1.06
14. Waste, &c.	0.30	0.30	0.30	0.30	0.30
15. Electrical labour	2.52	2.52	2.52	2.52	2.52
Relative cost of maintenance and operation ..	100.00	79.64	75.72	50.67	46.32
Relative investment in per cent...	100.00	82.50	77.00	100.00	91.20

"The first column covers a plant with compound condensing reciprocating engines without superheat, and is derived from a year's record of actual costs of a large plant operating with a load-factor of approximately 50 per cent.; load-factor in this case being defined as

$$\frac{\text{Actual output}}{\text{Maximum hour's load} \times 24}$$

"The values in the other columns have in the main been estimated from the first column, but wherever possible actual data derived from various sources, both domestic and foreign, have been used; but in all cases all values have been reduced so as to make them directly comparable with the first column, and with one another. The values in maintenance and operation of steam turbines are derived from actual costs."

In his summary of the proposition Mr. Stott concludes three items as follows:

"1. The present type of steam-power plant can be improved in efficiency about 25 per cent. by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

"2. The steam-turbine plant has an inherent economy 20 per cent. better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of causes shown in Table 2.

"3. An internal combustion-engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one half its present cost."

◆

Improving Operating Conditions.

"EVERY enterprising station engineer, in order to secure a healthy growth of business against increasing competition, diligently seeks to reduce his cost of production and distribution. Labour-saving appliances—such as fuel and flue gas testing instruments, superheaters, improved forms of steam and electric generators, better methods of conversion and distribution, together with a more intelligent idea as to the effect of load and diversity factors—have done much towards reducing these costs (allowing a corresponding decrease in the tariff charges to consumers), and yet finality in this direction, even with our present methods and knowledge, still lies some distance in the future."

So says Mr. Geo. Wilkinson in the opening remarks of an excellent paper recently presented to the Leeds I.E.E., and a cursory glance at the modern history of electricity supply will bear him out. He does not, however, state that such progress as may be made towards the reduction of the costs referred to will be altogether out of proportion to the development of the commercial section of the undertaking on sound business-getting lines. Still, no fault can be found with his subsequent remarks, which impress strongly upon his *confrères* the need for avoiding the waste and extravagance which now goes on almost unchecked on the consumer's side of the meter. He shows up a portion of the undertaking which has so far been grossly neglected by the engineer and is accordingly seriously prejudicing the advance of electricity supply. On his own system special attention has been paid to incorrectly graded and inefficient lamps, which by judicious co-operation with the customer are weeded out and reduced to a minimum. He says: "I have, in co-operation with the local contractors in Harrogate, developed a system of control over the lamps used in the supply mains which, while it secures to the Corporation the proper control, leaves the contractors the benefit of their trade in lamps, and puts no restriction upon them as to what make or class of lamp they supply to their customers. It is desirable that we should have legal powers to compel contractors to supply, exclusively, lamps approved by the supply authority; at present we are able to get a written undertaking only, and depend upon the contractors to abide thereby honourably; in Harrogate such undertaking appears to be quite sufficient, at present, to effect what we want."

Mr. Wilkinson, by insight and tact, is enabled to do what, legally, every undertaking should have power to do. The manufacturer has evidently fallen into line according to the following:—

"Considerable feeling was manifested on the part of several manufacturers due to the constant refusal of lamps: now, however, they appear to have settled down to comply with our requirements, and very few lamps which are now sent for certification fail to pass the required tests, and the consumer has already begun to feel the benefit of their improved efficiency. We have numbers of instances where the accounts have decreased since certified lamps were used, and the ultimate result is bound to be an increase of business accruing to the electricity department."

Mr. Wilkinson is decided enough on the matter of pressure-regulation, and rightly urges that as long as incandescent lamps possess a negative characteristic, *i.e.*, their resistance decreases with temperature rise, so long must strict attention be paid to close voltage regulation. The paper is well worth keeping for reference.

* * *

The Effects of Progress.

PROGRESS is invariably attained by generous contributions to the scrap heap. In no case is this more noticeable than electricity supply stations. If pioneer stations in this country alone are compared with modern plants the contrast is so dreadfully striking as to be almost unpleasant. One cannot conceive that a row of horizontal engines belted to a jack shaft to which arc lighters, alternators and d.c. dynamos are alike coupled, was the pride of electrical men of the early days. Singularly enough there are plenty of these stations doing service yet The recent annual convention of the North Western Electrical Association (Chicago) gives one a glimpse of the state of affairs in the backwaters of American electricity supply.

The President during his address, for instance, remarked: "You will find many central stations that have attempted to go into the power business which still have the 500-volt, direct-current apparatus, with perhaps the single-phase alternating system, on 125 or 140 cycles, and from that up; and they will do lighting work with open or enclosed series arc lamps on series arc machines. I think it is very necessary for them first to reorganise their systems before they go out actively after new business. Many central-station managers still favour high-frequency apparatus. They say the stuff is good enough for them; they are doing a pretty comfortable business, and there is nothing in the day-circuit proposition. They are still contented to give a dusk-to-daylight service. But if they do not give in soon and get on to a 24-hour basis in some way they will have, sooner or later, to yield to the inevitable.

"I think a great many people who are still holding to the 125-cycle proposition do it simply because they dread to tackle the job of putting in an entirely new outfit."

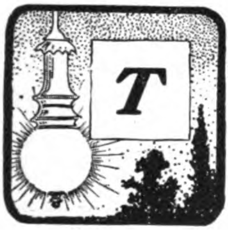
We are a little more up-to-date in this country at this stage of the development of the electrical arts.

LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Street Lighting.

By H. T. HARRISON, M.I.E.E.



The antipathy which engineers have so far shown to the actual measurement of street illumination is in the case of gas engineers, and to a smaller extent in the case of electrical engineers, due to the fact that they are in the habit of stating the value of a lamp as the candle power which it will give when measured in the best position and without any globes or lanterns; therefore, when measuring street illumination, a figure is generally obtained much lower than that claimed; but it is this actual figure which must be used for comparative purposes, and electrical engineers have much less to fear than gas engineers from this exposure.

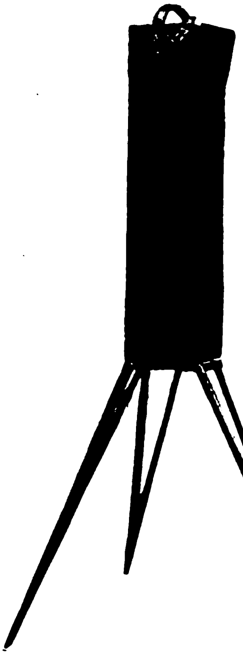
For instance, a Welsbach mantle consuming from 3.5 to 3.75 cubic feet per hour is generally stated as 70 c.p., whereas the very large number of measurements I have made during the last few years have shown that the average candle-power derived when measured in the street, is 35! Again a 200-volt, $\frac{1}{2}$-ampere "A" type Nernst lamp, according to the makers, gives 70 c.p. (heffner units); in practice I have found them equal to 37 c.p.!

Again, a 500-watt, direct-current, open-type arc lamp is generally called a 1000 candle-power lamp; whereas Mr. Bradley's tests and my own go to prove that they average 600 c.p. Another example is the new gas lamps in Fleet Street, which were claimed as 200 c.p., whereas the actual measurements I have made prove that they average 135 c.p.

In order to judge the lighting of a street it is only necessary to know the minimum illumination at any point where light is required, because if that illumination is sufficient for the purpose, it obviously follows that it will be ample elsewhere; to go to great trouble in order to obtain an average illumination is not only sheer waste of time, but also misleading; for example, the average illumination of a street brilliantly lighted in one part and left in comparative darkness in another part, may be high, but it is of no practical use except that you know that by moving from one brilliantly lighted spot to another you will travel along the street provided you do not encounter any unseen objects or dangers in the dark intermediate parts; therefore the measure of minimum illumination is of primary importance, and on its value the efficiency of the lighting of the street depends.

It will probably be suggested that the value of the maximum illumination should also be measured and stated in order that a diversity factor may be arrived at. This is to some extent true, as passengers in vehicles passing rapidly along a street having a large diversity of illumination are liable to become dazzled, moreover the value of the minimum is reduced if the iris of the eye is being periodically contracted by brilliant patches of light. Therefore we may take it that the best lighted streets are those with the highest minimum illumination and with the lowest diversity factor, and, after having granted this definition, all that remains to be done in comparing the lighting of various streets is to state the value of the maximum and minimum illumination as measured therein.

The illumination of a surface is proportionate to the candle-power of the light divided by the distance in feet, squared, which separate the light from the surface;



HARRISON PORTABLE PHOTOMETER FOR TESTING ILLUMINATION IN STREETS AND OPEN PLACES.
A Section of the apparatus is also given on this page. It is 27in. × 6in. × 6in., and is marketed by Everett, Edgcumbe and Co.

this unit is described as candle-power feet, but it *may* be necessary to remind you (Mr. Harrison was addressing the Manchester I.E.E.), that, unless otherwise stated, it is assumed that the illuminated surface directly faces the source of light, in which case the angle of incidence is 0; at any other angle the illumination of that surface would be reduced in direct proportion to the cosine of the angle of incidence, therefore it is necessary that, if any measurements are made on an instrument having a measuring screen which is horizontal or vertical or kept at a fixed angle, such a fact must be stated so that the measurements may be of value. To avoid the necessity of making such a statement, the obvious inquiry is—why not design the instrument so that the direct illumination is always measured? The answer is that it requires another adjustment every time a measurement is made, thus not only complicating the design of the instrument, but also increasing the time occupied in making the tests.

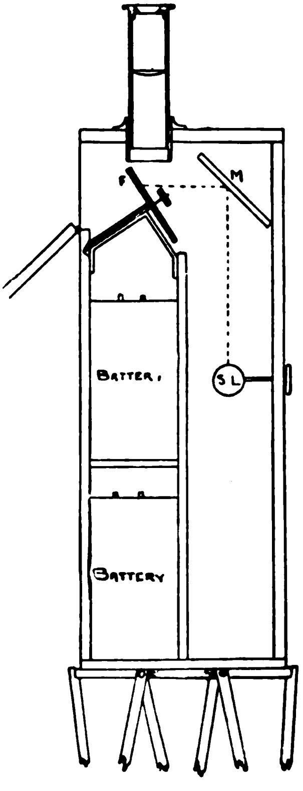
Therefore, for the purpose of measuring and comparing the illumination of streets, roads or open spaces, I would suggest that the minimum and maximum illumination, which can be derived at any point, be stated in units of candle power feet measured on a plane surface inclined to the vertical at an angle of 45°.

We may take it that in most towns the minimum direct illumination is as follows:—

Main Thoroughfares, minimum direct illumination	.050 c.p. ft.
Side Streets, minimum direct illumination	.025 c.p. ft.
Suburban Streets, minimum direct illumination	.005 c.p. ft.

These figures are averaged from actual measurements made in the street, and not from the fictitious values often claimed, and it is interesting to note that in many places where electric light has been installed—such as St. Pancras, Maidstone, Partick, &c.—these values have been exceeded, whereas the actual illumination obtained from gas mantles is generally much lower than that estimated by the representatives of the gas industry.

To ascertain the type of lamp to use for illuminating different classes of streets when basing calculations on minimum illumination it is necessary to know the candle-power derived from the lamps at an angle of about twenty to thirty degrees below the horizontal, and about ten degrees on the path side, and thirty degrees on the road side, of an imaginary line drawn parallel to the kerb; this is, of course, for posts erected on either side of the road, which is the present-day prac-



SECTION THROUGH HARRISON STREET PHOTOMETER.
SL is the standard lamp, which can be adjusted in a vertical direction; M is a reflector, and F the flicker disc of the photometer. Light from the lamp under test is admitted through the flap in the top left-hand corner. The eye-piece and lens at the top are used for viewing the two light sources on the revolving screen.

tice. For lamps giving an equal candle-power at all parts of the lower hemisphere, this figure will, of course, be the same as the mean hemispherical candle-power; but for lamps such as arc lamps, gas mantles, various types of Nernst lamps, and special reflector fittings, it must be taken from actual measurements made at the various angles. The following table is based on the average of a large number of measurements made in the street under working conditions.

(*Average mean candle-power of lamps* 20° *to* 30° *below horizontal, and* 10° *one side and* 30° *the other side of line drawn parallel to the street.*)

Electric Lamps.	Watts Consumed per hour.	Candle Power at angles stated.
(1) Flame Type	400	1300
(2) Open Type Arc	500	500
(3) Enclosed Arc	1000	1100
(4) "	600	550
(5) Reason Fitting Incandescent Lamps	200	120
(6) Reason Fitting Incandescent Lamps	120	70
(7) Reason Fitting Incandescent Lamps	60	30
(8) Reason Fitting Tantalum Lamps	70	110
(9) Nernst Lamps "A" Type ...	100—120	40
(10) Nernst Lamps "B" Type ...	50—60	15

Gas Lamps.	Gas Consumed per hour.	Candle Power at angles stated.
(11) High-pressure Mantles	30 c.f.	515
(12) " " "	20 c.f.	215
(13) Intensified Gas, 2 Mantles (City)	7.5	130
(14) 2 Low-pressure Gas Mantles ...	7.5	75
(15) 1 Low-pressure Gas Mantle ...	3.75	37
(16) " " " ...	3.2	32

It is now comparatively easy to set down the numbers of posts and fittings per mile necessary to obtain the minimum illumination generally provided for various classes of streets, but to facilitate this process, it is well to have a further table, showing the direct illumination derived at various distances from a lamp giving 1 c.p. at that point; with this it is only necessary to find the figure which when multiplied by the various candle-powers gives the required illumination, and then by turning to the distance column and multiplying it by two the resulting figure will be the distance separating the posts.

A statement worked out in this way will be found in the next table, the reference numbers relating to the lamps being the same as in the preceding table.

Distance apart of lamps of various types to give required minimum illumination.

Type of Lamp.	Main Thoroughfares. Min., .05 c.p.f.		Side Streets. .025 c.p.f.		Suburban Streets. .005 c.p.f.	
	Distance apart.	Posts per 1000 yds.	Distance apart.	Posts per 1000 yds.	Distance apart.	Posts per 1000 yds.
(1) Electric Flame..	300ft.	10	—	—	—	—
(2) Open Arc ...	200 "	15	—	—	—	—
(3) Enclosed Arc ...	300 "	10	—	—	—	—
(4) " " ...	200 "	15	300	10	—	—
(5) Reason Fitting...	100 "	30	140	21	300	10
(6) " " ...	70 "	43	100	30	250	13
(7) " " ...	45 "	66	65	46	150	20
(8) " " ...	90 "	33	130	23	290	10
(9) Nernst Lamp ...	55 "	54	75	40	180	17
(10) " " ...	—	—	65	46	110	27
Gas Lamps.						
(11) High Pressure ..	200 "	15	300	10	—	—
(12) " " ...	120 "	25	180	17	—	—
(13) Intensified .	100 "	30	140	21	—	—
(14) Ordinary .	75 "	40	105	28	240	12
(15) " .	50 "	60	75	40	170	17
(16) " ...	45 "	67	70	43	150	20

It must be quite understood that the above table is only approximate, and that it is simply put forward for comparative purposes.

The following table (p. 116) will give the average total cost per annum for all night lighting of 1000 yards of streets, under the various requirements and conditions of lighting.

All these tables demonstrate several interesting points, the importance of which, I consider, cannot be over-rated. They are as follows:—

1. The use of large units of light for general street illumination is expensive, and should be avoided where possible.

2. The cost of maintenance is very often as high, if not higher, than the cost of electrical energy or gas; it must be borne in mind that in the tables given electrical energy is taken at 1½d. per unit—it is very often less than this for street lighting, in which case the cost of maintenance becomes a still more important factor.

Street lighting will not come to those electricity undertakings the engineers of which do not use every effort to obtain it. Far too many engineers are prepared to sit still and allow the gas companies to retain this most valuable load and even more valuable advertisement; this class of engineer seems to forget that by his inaction in this direction he is practically crying "stinking fish" to his own undertaking. Those who have studied the matter carefully are aware that in nine cases out of ten the lighting of the streets still remains in the hands of the

Total Cost per Annum (4000 hours) per 1000 yards of Street.

MAIN STREETS.				SIDE STREETS.				SUBURBAN STREETS.			
System.	Supply.	Maintenance.	Total.	System.	Supply.	Maintenance.	Total.	System.	Supply.	Maintenance.	Total.
Electric.	£ s. d.	£ s. d.	£ s. d.	*Electric.*	£ s. d.	£ s. d.	£ s. d.	*Electric.*	£ s. d.	£ s. d.	£ s. d.
(1)	100 0 0	90 0 0	190 0 0	(1)	—	—	—	(1)	—	—	—
(2)	187 10 0	135 0 0	322 10 0	(2)	—	—	—	(2)	—	—	—
(3)	250 0 0	45 0 0	295 0 0	(3)	—	—	—	(3)	—	—	—
(4)	225 0 0	60 0 0	285 0 0	(4)	150 0 0	40 0 0	190 0 0	(4)	—	—	—
(5)	150 0 0	25 0 0	175 0 0	(5)	106 5 0	21 0 0	127 5 0	(5)	50 0 0	10 0 0	60 0 0
(6)	129 5 0	43 0 0	172 5 0	(6)	90 0 0	30 0 0	120 0 0	(6)	39 10 0	13 0 0	52 10 0
(7)	98 15 0	66 0 0	164 15 0	(7)	62 15 0	46 0 0	108 15 0	(7)	30 0 0	20 0 0	50 0 0
(8)	56 5 0	100 0 0	157 0 0	(8)	40 5 0	63 0 0	103 5 0	(8)	17 10 0	27 10 0	45 0 0
(9)	150 0 0	59 8 0	209 8 0	(9)	112 10 0	44 0 0	156 10 0	(9)	46 15 0	18 14 0	65 9 0
(10)	—	—	—	(10)	62 10 0	50 12 0	113 2 0	(10)	37 10 0	29 14 0	67 4 0
Gas.				*Gas.*				*Gas.*			
(11)	180 0 0	105 0 0	285 0 0	(11)	120 0 0	70 0 0	190 0 0	(11)	—	—	—
(12)	200 0 0	137 10 0	337 10 0	(12)	172 0 0	93 10 0	265 10 0	(12)	—	—	—
(13)	180 0 0	67 10 0	247 10 0	(13)	63 0 0	47 5 0	110 5 0	(13)	—	—	—
(14)	120 0 0	70 0 0	190 0 0	(14)	84 0 0	49 0 0	133 0 0	(14)	36 0 0	21 0 0	57 0 0
(15)	90 0 0	90 0 0	180 0 0	(15)	60 0 0	60 0 0	120 0 0	(15)	25 10 0	25 10 0	51 0 0

gas companies, simply on account of the business push and acumen of their managers. Is it surprising that gas companies in many cases retain this branch of the business when many electrical engineers are so disinterested in the matter as not to trouble to find out what can be done?

◆

Gas and Electricity as Illuminants.

By S. M. HILLS.

MOST attempts to produce an efficient source of light have resulted in the provision of intense sources, usually concentrated in small areas. However useful these may be for certain purposes, until they are placed behind diffusing screens, they are an absolute failure domestically, on account of the enormous contrast and sharp shadows which they produce. Thus, a room illuminated by one 16 c.p. lamp will not be so well lit as if sixteen 1 c.p. lamps were distributed about it. This is one of the cardinal points to be observed when illuminating an area.

The distribution of light in small elements is much more easily accomplished with electricity than with gas, where nothing short of an expensive and complicated system of pipes would meet the case.

The most pleasing illumination is one in which the dominant wave length is situated in the yellow region of the spectrum, and this is admirably met in glow lamps, and the more modern flame arcs, while the dominant wave length in the case of the incandescent mantle is in the green region; thus a cold light is obtained.

Cost.—To attempt a comparison of gas and electricity that will be perfectly fair to both is a thankless task, because the advocates of either condemn a disagreement with their sentiments with the energy of an Old Bailey lawyer; and exceedingly difficult because of the lack of uniformity in standards. Advertised tests are generally laboratory or picked tests to catch the eye of the public so that he who runs may read.

What, for instance, is the meaning of "500 candle power lamp" or a mantle of "50 candle power"? Does the latter mean candle foot power, for I have learnt to be cautious in accepting statements of advertisers and even commercial travellers, or stall holders at electrical exhibitions? I have endeavoured to be perfectly fair, and because the time given me did not permit of personal experiment, have used figures based upon personal observation of myself and friends, and also those supplied by reputable authorities. Doing this and assuming gas to be 3s. per 1000 cubic feet, and electricity at 4d. per unit flat rate, I have made the following comparisons in terms of candle hours per Board of Trade unit.

Glow lamps consuming 2.53 watts per candle power give a minimum of 500 candle hours per B.T.U. This assumes a useful life of only 500 hours, and the lamps may be usually run considerably longer than this. While in the case of the "Wytelite" or high efficiency lamps the consumption is only 1.5 watts per candle power, and hence instead of

500 we may state about 1000 candle hours per B.T.U. In the case of the Nernst lamp the mean value is 600 candle hours per B.T.U.

Ordinary arc lamps have a minimum value of 1300 candle hours per B.T.U. Flame arc lamps attain the enormous value of 6680 candle hours per B.T.U.

The most favourable case, on the other hand, for gas is the incandescent burner, and here we obtain 718 candle hours for the same average price as the B.T.U. Hence it will be observed that the only instance which is seriously less than that of the incandescent mantle is that of the glow lamp. While I must call attention to the fact that I have endeavoured to give the mantle the most favourable consideration, I have not extended the life of the glow lamp to the length it is generally allowed in practice. The extreme fragility of the mantle renders its use unsatisfactory where lighting is done by careless people, for careless lighting, like vibration and draught, easily causes breakage. Much of the effective light is lost by the use of the enclosing chimney of high absorption—this absorption amounting in some cases to 20 per cent.—and is not included in the figures given here. The renewal of mantles and breakage of these chimneys, due to sudden changes in temperature, add to the cost of gas used with a mantle burner.

If I may be permitted to use a sporting expression and now call "time" in the contest of gas *v.* electricity, and stand as umpire to compute the points, I should sum up as follows:—

Gas.—You have been established as an illuminant for 50 years. Till lately you have exercised your monopoly in a bullying manner, and rarely called in the aid of science. The time was when bye products were wasted, and anon bye products were all important. The consumer had to accept poor and dear gas or none at all. Not until your rival electricity appeared did invention trouble gas companies, so that now the appeal is made, gas is economical because a small quantity can be used to secure good illumination.

Electricity.—You are comparatively young, but your steadiness and general convenience has caused your rival to go into stricter training. You have many natural advantages, but be not overbearing. Take the lesson you taught him, and let invention assist you so that you can be produced at a cheaper rate.

I am fully aware that municipal production has not been altogether in your favour; that the repayment of capital often prevents you scrapping comparatively old machinery, and charging a low price. Overcome your lack of staying powers, invent an efficient method of storage, and the victory is yours.

Gas v. Electricity.—I declare the contest to-day to be slightly in the favour of gas, on economical points. But it is a doubtful victory if other points could be allowed, points which I fear some would consider as personal or sentimental.

Flame Arc Lamps.

THE interest taken in flame arc lamps has now reached a point which may well give anxiety to the gas industry. The literature of the subject is by no means exhausted, and we may welcome an article on this new type of lamp by Mr. L. Pumphrey in the Electrical Engineer. The following extracts emphasize the importance of flame arc lamps in the street lighting field.

When gas engineers invented patent high-pressure systems, they began to creep up unpleasantly near to the old types of arc lamps. Fortunately, however, for the electrical industry the flame arc was invented, and the gas people are thus once again left in the rear. It is to be hoped that electrical contractors and supply engineers will not be slow to realise and make vigorous use of this most recent and most potent weapon that has been placed in their hands. There is a tendency for station engineers to lose perspective of the efficiencies of the apparatus for which they are responsible. By this statement it is meant that there is too much haggling over farthings in works costs and losses of 1 per cent. in the dynamos or feeders, while the arc lamps in the streets, by which the electric supply is to some extent judged by the public, are of an antiquated type, with an efficiency not 50 per cent. of that of the latest patterns. The result has been, in some cases, that the gas-man has stepped in with his latest and most improved system and captured the lighting contract. It may be that he has to sell his gas at less than cost price to do this, but he knows that as an advertisement it is well worth the small expense involved.

The greatest claim that the flame arc lamp has upon the attention of electrical engineers is its extraordinary efficiency, which in the best lamps approximates one-tenth of a watt per candle-power. The great efficiency of these lamps is also partly due to the fact that almost the whole of the light is thrown in a useful or downward direction. The impregnated salts in the carbons are found to have a most curious effect upon the electrical efficiency of the lamp. This relation is as yet not properly understood, and the carbon manufacturers have been to some extent working in the dark on a trial and error principle. It is probable, however, that before very long the way in which these salts affect the light efficiency will be reduced to a more exact basis.

In a standard type of lamp the carbons project downwards at a slight angle through a porcelain cup, and an electromagnet serves to bow the flame across between their lower tips. Craters are formed on both carbons, and as these point in a downward direction, all the light that may be due to them is usefully distributed. The economiser serves a useful purpose in reflecting the light and protecting the flame from air currents, to which it is very sensitive. It also has the beneficial effect of limiting the supply of oxygen and thus increasing the life of the carbons. The tendency to form sharp shadows is decreased owing to the relatively large light-emitting surface, and it serves to increase the temperature of the flame, thus giving a greater light intensity. In order that the metallic salts may fulfil their function, oxidisation must take place, and this factor has to be taken into consideration in the design of the lamp. In the first place, total enclosure is impossible, as a limited supply of oxygen must gain access to the arc; the air that leaks in through the joints is usually quite sufficient for this purpose.

In view of the claims that have been made for flame arc lamps in the course of this article, it is interesting to note exactly what bearing these have upon the street-lighting problem as it exists in London to-day. The following table (I.) is extracted from one of Mr. Bradley's sets of experiments in the streets of Westminster.

TABLE I.

Description of Lamp.	Candle-power.	Total cost per lamp per annum.	Total cost per candle-power per annum.
		£ s. d.	
High-pressure gas (Whitehall)...........	552	18 5 0	7.95
Electric arcs (Grosvenor Place).................	691	22 0 0	7.65

There is little to choose between the two illuminants. In a report of the Westminster Testing Laboratory dated March 11, 1905, the mean hemispherical candle-powers of a flame and an ordinary arc (tested under identical conditions) are given and summarised thus:

TABLE II.

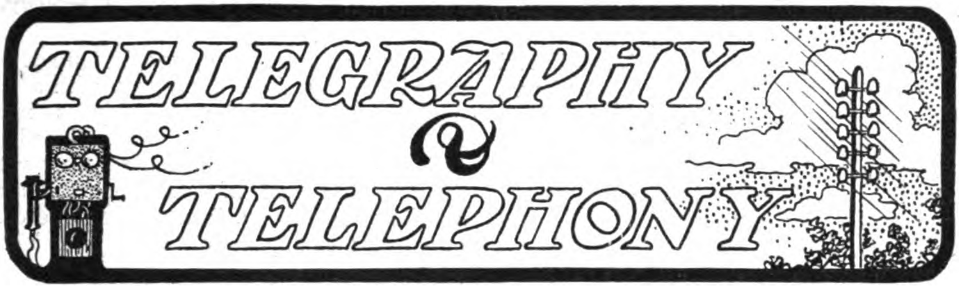
——	Watt consumption.	Mean hem. candle-power.	Watts per M.H. candle power.
Ordinary arc lamp....	476	633	.75
Flame arc lamp	382	1352	.28

If we take the ratio $\frac{75}{28}$ as representing the superiority of the flame lamp, we are well within the mark. For with higher powers and the latest types as low a figure as .15 watt per candle-power has been attained. We must emphasise the fact that while the gas people have played their last card, we have two more. In the first place, we have far more efficient lamps than those which gas has hitherto fought, and, secondly, we are going to have cheaper power. If the London County Council Bill is passed (which it surely will be) energy will be supplied to the distributors at .4d. per unit, and (allowing 20 per cent. profit) will be delivered at the lamp terminals at .5d. per unit. Assuming that the superiority of the flame over the ordinary arc is not greater than is represented by $\frac{75}{28}$, and that energy at .5d. per unit will bring down the cost per annum of a 750-watt lamp from £22 to a maximum of £13, what is the effect upon Mr. Bradley's figures?

TABLE III.

Description of Lamp.	Candle-power.	Total cost per lamp per annum.	Total cost per candle-power per annum.
		£ s. d.	d.
High-pressure gas (Whitehall)	552	18 5 0	7.95
Ordinary arc lamp (Grosvenor Place)............	691	22 0 0	7.65
Flame arc lamp	1850	22 0 0	2.85
Flame arc lamp (at .5 per unit)	1850	13 0 0	1.68

In this way we see at once that the case for gas is absolutely hopeless.

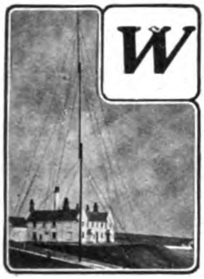


TELEGRAPHY & TELEPHONY

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Factors Governing the Design of an Exchange.

By W. H. RATCLIFFE.



WHEN a telephone engineer is called upon to design a telephone exchange, the first matter which presents itself for consideration is that of the location and size of the exchange. The proper location is such that the sum of all the subscribers' line lengths, measured along streets, is a minimum. This point can best be determined graphically by plotting on co-ordinate paper the relative locations of the prospective subscribers and then dividing the plot into halves, first with respect to a vertical axis and then with respect to a horizontal axis. The intersection of these two perpendicular axes will give the proper location for the exchange. This central location, while being such as to give the minimum outlay for line construction, which is the largest item in the cost of the exchange, may be counterbalanced to a certain extent by the disadvantages of high rent, noise, &c. Such matters should merit due consideration before arriving at a conclusion, as the removal of an exchange when once equipped is a costly undertaking.

The first cost of the exchange, considered as a whole, is governed by a number of factors, each of which may vary to a considerable extent. These factors may conveniently be classified as the cost of the distributing boards, the cost of the switchboard with its accessories, the cost of the power plant, the cost of interior and exterior wiring, and the cost of subscribers' instruments.

Assuming that the size of the city be such that a single exchange meets the requirements, the first cost will be governed largely by the type of switchboard installed, and this in turn will depend upon the number of subscribers. If it be estimated that the ultimate capacity will not exceed 1000 subscribers the transfer switchboard should be selected, while for a larger number of subscribers a multiple switchboard should be chosen in preference to one requiring a trunking system between the operators. The reason for thus distinguishing between the two types of switchboards are as follows: In a small exchange the stripping trunk lines between operators perform their functions well and do not greatly interfere with the service, while the simple construction of the transfer switchboard enables repairs or alterations to easily be made. The intricate wiring of the multiple board is therefore unnecessary in such a case, and its comparatively high cost of maintenance unwarranted. In a large exchange, however, the multiple switchboard affords far better service than could be expected from a transfer board, and the multiple type is here cheaper to operate because less operators are needed and the magneto-generators and local batteries in the subscribers' instruments may be eliminated, thus saving their first cost as well as the cost of their maintenance. Regarding the difference in first cost of the two types of switchboards, it may be stated that for the same capacity the multiple switchboard is about 150 per cent. more expensive than the best type of transfer switchboard.

The first cost of the power plant if the exchange is to generate the current it uses will be that of the boilers, engines, generators, storage batteries, power switchboard and accessories, while if the current be purchased the cost of whatever transforming and storage apparatus is used, such as motor-generators, dynamotors, and storage batteries is included under this head, as well as the cost of the power switchboard and power switchboard accessories. To provide against any interruption of service it is necessary to instal a duplicate set of generating or transforming apparatus, as the case may be.

The great difference between the cost of overhead line construction and that of underground line construction favours the use of the former in all cases except for thickly populated districts. Commencing at the exchange, however, as much of the line construction should be placed underground as the money on hand will allow, for what is spent in this way will materially lower the maintenance of the line and thus prove a good investment. The subscribers' instruments should be chosen with great care, selecting only those best adapted to meet the requirements demanded of them. As far as is consistent, however, all the apparatus employed should be purchased of one concern, although it is well to invite bids from a number of manufacturers, supplying them in each case with the necessary specifications.

Before leaving the important question of the first cost of an exchange, it may be well to give the reader some figures whereby he may form an idea of the capital required in any given installation. The figures presented are, of course, only approximate, and will vary according to fluctuations in the cost of materials; they are based, however, on prices which exist at the present time and on modern methods of construction as previously outlined. An exchange of 500 telephone instruments, located within an ordinary radius and wired throughout on open wire pole lines, will cost as a whole about £13 per instrument; an exchange of 1000 telephone instruments employing the transfer system and overhead cables, but no underground construction, will cost approximately £17 per instrument; an exchange of 2000 telephone instruments using the common battery system and underground cables, will cost about £20 per instrument, and for exchanges of the latter type exceeding in size 5000 telephone instruments the cost will be approximately £32 per instrument. The annual cost of operating an exchange may be pre-determined for any given installation with a fair degree of accuracy, and includes rent, interest, and depreciation on the wire plant and subscribers' instruments, together with their annual cost of maintenance; also salaries of employees, fixed charges, and cost of current supply.—Abstracted from Telephony.

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The Jones Phantoplex Telegraph System.

A SYSTEM employing alternating currents of equal frequencies to be superimposed upon ordinary telegraph wires already being operated by the present Morse systems, either single, duplex or quadruplex, has recently been developed and patented by Mr. Francis W. Jones, electrical engineer, of the Postal Telegraph-Cable Company, for the purpose of giving additional facilities to present telegraph wires for the transmission of messages by the Morse code.

The utilization of alternating currents, both of equal and unequal frequencies, has been tried for the same purpose by many inventors, commencing many years ago with Cromwell F. Varley, in England. The most successful applications having been made in the United States by Thomas A. Edison, A. C. Crehore and Harry O. Rugh, whose systems have been in practical operation upon telegraph lines with more or less success, but which systems have not proved as satisfactory to telegraph managers as they desired. Elisha Gray's system for a similar purpose employed direct currents and therefore was dependent upon paths of non-inductive high resistance around his Morse apparatus to admit of the passage of his pulsatory signals, and for this and other reasons the Gray system was not put in use by the telegraph company which controlled the patents.

Mr. Jones' system, which has been given the name of the "Phantoplex" on account of its creating what is known as a "phantom" circuit, has been in practical operation upon the wires of the Postal Telegraph-Cable Company for several months, and the results of its operation are stated to be highly satisfactory.

The alternating currents employed have a frequency of about 150 per second, and an effective e.m.f. of about 100 volts, for an ordinary telegraph circuit about three hundred miles long, not including way offices. The transformer has been designed to make a transformation of maximum efficiency of the alternating currents, in the line wire; a capacity of at least six microfarads has been given to each condenser placed around the relays, and at the ends of the Morse circuit, to furnish an electrostatic path of low impedance for such transformed alternating currents. It is found that the currents used for "Phantoplex" signals, on account of their high rate of alternation, do not affect the Morse apparatus, either in the circuit being operated, or in a circuit being operated upon an adjacent wire upon the same cross arms. It is well known that if a speaking telephone circuit is established through the coils of a sensitive astatic galvanometer, that the mirror of the latter will not be set in motion by the operation of the telephone, the electric sound waves in the telephone being of high and variable frequencies; but if an instrument as sensitive as the Bell receiver is included in the circuit, the electric sound waves will set its diaphragm into audible motion; similarly the ordinary Morse relays connected directly in the "Phantoplex" wires, or which are being operated in a wire adjacent thereto, are immune from the effect of such currents, but they are likely to produce a hum or note corresponding to their rate per second in any unbalanced telephone wire running parallel within a short distance of the "Phantoplex" circuit.

The Jones system was worked satisfactorily between New York and Hartford, 142 miles, upon a wire that was being worked quadruplex between New York and Boston, 260 miles, and not the slightest interference could be detected between one system and the other. In fact, the operators working upon the quadruplex could in no manner be aware when the "Phantoplex" was in operation; neither could the operators upon the "Phantoplex" circuit tell when the quadruplex was being operated.

A "Phantoplex" circuit is being operated between New York and Utica, 300 miles, upon a wire that is duplexed between New York and Buffalo, 450 miles, in the most perfect manner and without the slightest interference. This wire contains about ten miles of underground and one mile of submarine cable. There is no reason to believe that this system will not work through much greater lengths of underground and submarine cable than the speaking telephone, on account of its containing no overtone alternations for the purpose of reproducing speech. Many other circuits under similar conditions are being operated with the same results.

A number of patents have been granted to Mr. Jones on this system. One broadly covers the particular combination and means for "Phantoplex" sending and receiving; also for superposing the system upon the ordinary polarized Morse duplex circuit, by which two "Phantoplex" communications can be made simultaneously in opposite directions, at the same time that two Morse messages are being transmitted in opposite directions. Another shows the connections for the superposition of the "Phantoplex" upon a duplexed or quadruplexed wire. In this case, the wire between the stations is utilized for "Phantoplex" transmission in either direction, while the duplex or quadruplex apparatus is being operated for the transmission of messages by the Morse system in the usual manner. Still another shows a means for repeating from a "Phantoplex" circuit upon one Morse wire directly into another Morse wire not equipped with "Phantoplex" apparatus. The second

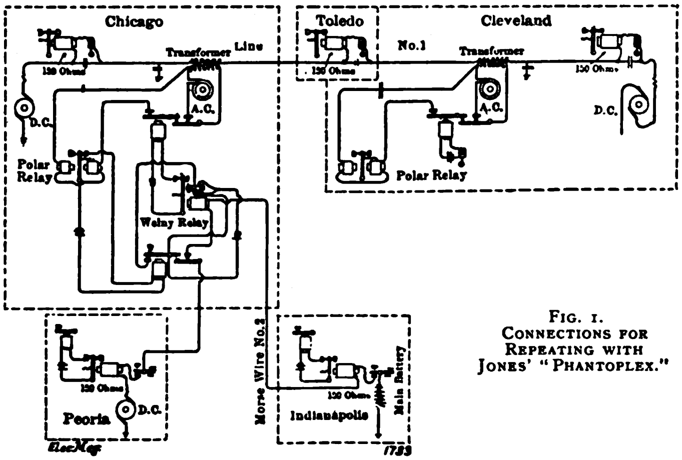

FIG. I.
CONNECTIONS FOR REPEATING WITH JONES' "PHANTOPLEX."

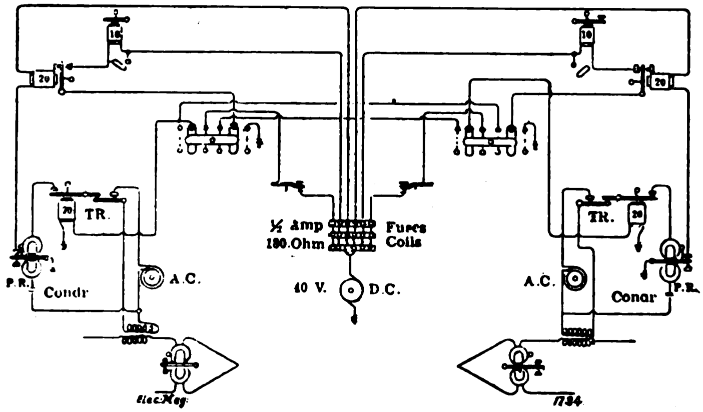

Fig. 2. "Phantoplex" Repeater Connections for Duplex Working.

Morse circuit, marked No. 2 in Fig. 1, should be equipped with keys which open and close the line at the under side of the rear end of the lever, instead of at the contact point, as shown under the end of the lever upon which the knob is mounted; and the sounders of the relays should be operated from the back contact points of the Morse relays that are worked in this circuit. This can be easily arranged by the use of special keys and three-point switches to change the key contacts and local sounder contacts from front to rear.

Fig. 2 shows a "Phantoplex" repeater for carrying the signals from an eastern duplexed wire at any repeater station, over a western duplexed wire, and *vice versa*, with switches for separating the "Phantoplex" sets, so that they may be worked independently both east and west from the repeater station. The same repeater answers for wires that are being worked single or quadruplex. Fig. 3 is a plan for connecting a "Phantoplex" circuit, being worked upon a way wire between New York and Boston, with a duplexed circuit in the New York office, operated by the Morse system between New York and Washington, as shown. When Boston is sending by "Phantoplex" to Washington *via* the New York "Phantoplex" repeater, it is necessary for Washington to keep his key open, instead of closed, as is the case at present when Morse wires are connected to duplex circuits through half repeaters.

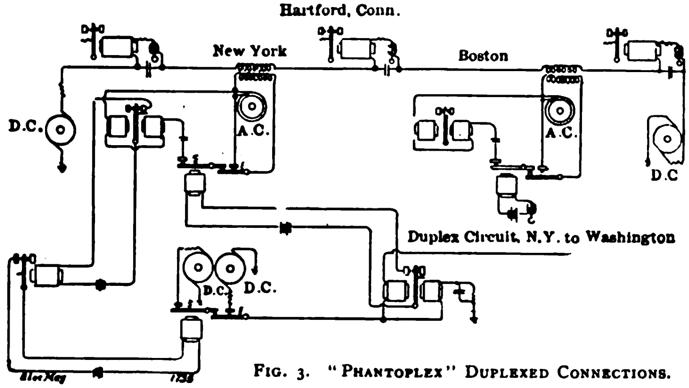

Fig. 3. "Phantoplex" Duplexed Connections.

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Telegraphy Correspondence Class.—X.

Conducted by CICERONE.

In answer to the three simple questions asked in the November issue, some good matter has been produced, and as showing some of the different ways that the same idea may be expressed, a few examples will be quoted *in toto.*

"A stress," says one correspondent, "is a force acting on a body. A strain is the effect produced in the body to which a stress is applied. Briefly, a stress applied to a body strains it."

The above is concise and accurate. When a telegraph line is subjected to weather stress, or wind pressure, the line is strained. The one is the cause, the other the effect, and the latter is proportional to the amount of stress and pressure to which it is subjected.

Treyar has got somewhat mixed in his definitions, apparently due to his reference to untrustworthy text books. "Strain is an external force," he says, "which tends to cause rupture, and stress an internal force exerted to resist the same. When the wires on a telegraph pole are tightened, they exert tensile strength in resisting the strain acting on them to pull them asunder, and this internal force, or stress, in acting externally on a terminal pole, becomes a strain, and causes the support in resisting rupture to exert transverse stress, which acts externally on the wires as strain."

In Preece and Stubbs's Manual of Telephony the authors say it is very desirable to note the distinction between stress and strain, and then proceed to say that "the strain of a body is the proportion of itself by which it lengthens. It is therefore a distortion. The stress is the load per square centimetre, or per square inch, which produces this strain. It is therefore a force. Stress is cause, strain is effect. The tensile strength of a wire is the stress it will bear before it breaks. It is frequently called the breaking weight. The elastic strength is the stress which produces a permanent set, and it indicates the limit of elasticity." A lengthy definition, but not very lucid. In brief, it states that strain is a distortion and stress a force. It would be better to define the difference in this way. Stress is the force which, acting by pull or pressure, produces a strain upon a body.

The second question, involving a description of the survey of the route for a telegraph line, does not admit of brevity particularly, but one correspondent has succeeded in embracing all the main points in the following words :—

" In surveying a section of road prior to the erection of a line of telegraphs the objects to be attained are :—

" I. The best possible positions for the poles and wires as regards (*a*) facility for construction and maintenance ; (*b*) freedom from interruption, *i.e.*, clearance from trees, houses, passing vehicles, &c.

" II. An approximate estimate of the quantity and description of material required.

" III. Facilities for laying-out of such material in readiness for construction.

" IV. Particulars of wayleaves, where required.

" In attaining these objects the following particulars should be noted :—

" Number, description (single, A or H), and positions of poles required ; number and description of wires to be erected ; lengths of spans ; position and number of stays and struts ; number and lengths of arms required ; number and description (ordinary or terminal) insulators ; miscellaneous stores ; points at which stores may be laid out and allowed to remain free from interference for a short time. The line should follow the inner side of the road where a curvature exists, and should as far as possible avoid trees, houses, and the crossing of the main road more than is really necessary."

An essay on overhead line construction, which constitutes the subject of the third and last question, is not easily confined to a limited space, but one or two answers are wonderfully comprehensive, and yet not unduly prolix or diffuse. Treyar discourses as follows :—

" Poles are the first consideration in the construction of a telegraph line, and these are mainly of red fir from Norway and Sweden, thoroughly preserved either by boucherising or creosoting, the antiseptic in the first being copper sulphate, and in the second creosote. There are three classes of poles, light, medium, and stout, carrying a maximum of five, ten, and over ten wires respectively. The distance between each pole varies with the route, the average being about 26 poles to the mile. Length also varies with the route, together with the number of wires carried. The holes to receive the poles should be dug in line with the wires to a depth of about one-fifth the length of the pole, and gradually narrowed down to about the diameter of the same. Too much care cannot be exercised in well punning the earth as it is being replaced. At a distance of every half mile each pole should be stayed or strutted according to which is the more suitable, and in addition to this it is necessary to support those poles erected where the line takes a sharp curve. All terminal poles should be well stayed or strutted. The stay, which is a stranded wire rope, should be attached to the pole by means of a double noose secured with staples at the resultant point of the several strains, and spliced back on itself by unstranding the wires and winding each one in turn round the joint, the other end being passed through an adjustable swivel having an eye and secured in the same way. Attached to the swivel by means of a screw is a strong galvanized iron rod, the opposite end of which is bolted to a block of preserved timber secured firmly in the ground by under-cutting. As the stress exerted by the stay against the tension of the wires is directly proportional to the cosine of the angle it makes with the pole, it is advisable that the distance measured along the ground between both should equal the distance from the resultant point to the ground. Struts are neatly scarfed and bolted to the pole immediately underneath the lowest wire, the joint tarred, and a good foundation of stones placed in the hole to give the lower end a firm thrust. It is safer to bind both strut and pole together about centre-ways by means of an iron rod, and again below the ground with a block of preserved timber. A piece of oak called the arms is fitted into a groove formed on the up side of the pole and bolted by its centre at right angles to a pole carrying more than one wire, and this is repeated for every additional two wires carried ; but the first and every alternate arm, each being of the same length, project beyond the second and intervening arms, which are also of similar but shorter lengths. Such an arrangement enables a broken wire to fall clear of the others, avoiding contact. Bolts with a thread at the top are fixed perpendicular to the arms, and on these the insulators are screwed."

Pelmar shows greater originality of description, and is more succinct, without omitting anything essential to a complete and comprehensive answer to the question, although it does partake less of the essay form than that just quoted. As a contrast, however, it will be found very interesting, and is given *verbatim.*

"The main points to be noted with regard to overhead line construction are :—

(i.) Stability.
(ii.) Efficiency.
(iii.) Economy.
(iv.) Future requirements.
(v.) Maintenance facilities.
(vi.) Appearance.

"The stability of a line depends upon the dimensions and soundness of the poles, arms, struts, stays, and other fittings. The poles should be stout enough to carry the number of wires proposed, and of sufficient height to allow for future needs. They should have undergone one of the preservative processes—preferably creosoting. The arms should be of well-seasoned timber, free from knots and sap. The materials employed for stays, struts, and other fittings, should be of the best.

"Efficiency is regulated by the quality of the insulators and the material and gauge of the wires, but the latter must be varied to suit the apparatus it is intended to work upon each circuit. Efficiency also depends in a great measure on the stability of the line—the stronger the line of course the less liability there is of interruption through stress of weather.

"Economy in construction is mainly effected by proper surveying—the best and most suitable points being selected for the erection of the poles, it follows that less time and labour are required than where unsuitable positions are chosen. Considerations of cost would disallow the use of unduly stout poles, or an excessive number of struts or stays ; but great discretion is needed here to prevent the stability and efficiency of the line being sacrificed to cheapness of first cost.

"Future requirements. It is somewhat difficult here as elsewhere to foretell what may happen in the future, and each case must be treated strictly on its own merits ; but by allowing a good margin as regards the stability of the line it may safely be expected to carry a few additional wires, with possibly an extra stay or two at doubtful points. Should the number of wires increase rapidly, then the difficulty will be solved by conversion to 'H' poles where a single line has been erected.

"Maintenance. This includes ease of supervision, freedom from serious interruption, and facilities for detection and removal of faults.

"Appearance. The appearance of the line should be a consideration, but mainly a secondary one. Where the appearance of the line can be improved without endangering its stability, the improvement should be carried out. As an instance, the use of a creosoted pole may be objected to at a particular point and a square painted pole may be substituted providing it does not weaken the line where it is placed."

Treyar is wrong in fixing the strut just below the lowest wire on the pole. The ultimate resultant point is the proper position for the fixture.

The same correspondent sends some particulars of a test for self-induction by one operation, about which he has some difficulty, and upon which he wants information. It appears as if there were some initial mistake in the method supplied to him, as both the inductive and non-inductive resistances, as well as the capacity, are inserted in one side of the bridge instead of being properly distributed in the arms. It resembles Clerk Maxwell's method to some extent, and a modification of it by Lord Rayleigh. Carey Foster, too, has a method somewhat similar, and a simple, although not a scientifically perfect, mode of measuring inductance was devised by Kempe, which will be found in his Handbook of Testing. Others more elaborate are given in detail in the works of Glazebrook and Stewart and Gee. In one method, which looks like the one Treyar is after, the inductance L occupies the balancing arm, and a non-inductive resistance R, in shunt with a condenser K, occupy the fourth arm of the bridge, the ratios a and b being non-inductive as usual. First balance for steady currents and note the deflection d_1 on breaking the battery circuit. Then disconnect the condenser and note the deflection d_2, on again breaking the battery circuit. The presence of the condenser capacity K will tend to diminish the effect of L by C a b.

Therefore $d_1 \propto L - C\,a\,b$ or $L - C\,R\,r$, where $r =$ the ohmic resistance of the induction coil.

Also $d_2 \propto L$ when K removed.

$$\text{Hence } \frac{d_2}{d_1} = \frac{L}{L - K\,a\,b.}$$

$$\therefore L = \frac{d_2}{d_2 - d_1} K\,a\,b.$$

And now I come not only to adjudicate and announce the result of the work of the students for the year that has elapsed since the class was inaugurated, but to the sadder duty of saying farewell to them. In the work of the year Treyar and Pelmar have been equally and consistently good. Summing them up, they both total an equal number of marks, and the prizes offered will be divided between them.

There can be no doubt that the class was taken advantage of by a very large number of telegraph and telephone readers, who were content to read and profit by the work of others, but not to enlist in the army of competitors. This, of course, was not what was intended, and as the number of active students did not reach expectations, the management have reluctantly abandoned the scheme for the present.

In saying farewell to my correspondents, to many of whom I have felt personally attached, I wish them every success, and trust that their short acquaintance with Cicerone may never awaken anything but pleasant memories.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

Electrical Nature of Matter and Radioactivity.

By HARRY C. JONES.

THE most strongly radioactive substances —radium, actinium, polonium—apparently occur in very small quantities. Even the more feebly radioactive elements, thorium and uranium, are not among the more common chemical elements.

A question of very great importance in connection with the study of radioactivity is this; is radioactive matter small in quantity and confined to a few sets of conditions, or is it widely distributed? The fact that it exists in any one locality, or with any one association, only in small quantity, does not throw any light on the question of the scope of its distribution.

Radioactive Matter in the Earth.

It has been shown by Elster and Geitel that air confined in spaces in contact with the earth, such as certain caves, becomes radioactive. This was shown to be due to the presence of radium in the ground, which diffused into the air, since air confined by itself in a metal vessel away from contact with the soil, did not become radioactive. The same result was obtained, and to a more marked extent by taking air from some depth below the surface of the soil by means of a pump. Such air contained sufficient of the radium emanation to induce radioactivity upon the walls of the containing vessel. The radioactivity decayed at such a rate as to leave no question that it was produced by the radium emanation.

It was shown by Ebert that air which is radioactive loses its radioactivity when passed through a tube surrounded by liquid air. It will be remembered that Rutherford, by this means, condensed the emanation from radium and obtained it in the liquid condition. This is another bit of evidence that goes to show that the radioactivity of the air in contact with the earth is due to the radium emanation.

The amount of radioactive matter in the soil seems to vary greatly from place to place. Clay soil seems to be the most radioactive, but sandy soils are not infrequently radioactive.

A piece of non-radioactive clay was buried at some depth in the earth, and was found after a time to become radioactive. This was an induced radioactivity, due to the deposition upon it of radium emanation. When air is sucked through clay, it was shown by Elster and Geitel that it manifested considerable radioactivity.

Carbon dioxide that came from great depths in the earth was found to be radioactive. It lost its radioactivity on standing for some days.

A quite appreciable quantity of radioactive matter has been found in certain waters that percolate through the soil, and especially in those that come from considerable depths. J. J. Thomson has shown that the tap-water of Cambridge contains radioactive matter, while the waters from certain deep wells were found to contain quite appreciable quantities of the highly radioactive emanation. This emanation decayed at such a rate, as compared with the emanation from radium, as to show that the two were identical.

Radioactive Matter in the Air.

It has long been known that a charged body surrounded by air loses its charge more rapidly than can be accounted for by the leak through the supports. This would show that the air is ionised to some extent. The cause of this ionisation remained for a long time unknown, and, indeed, has only recently been discovered. After the discovery of radium and its comparatively wide distribution, it occurred to Elster and Geitel that radium might be present in small quantity in the air, and if so, this would account for the ionisation and conductivity of the air. They undertook to test the atmospheric air for the presence of radioactive matter, and in the following manner

It had already been shown by Rutherford that a negatively charged wire, suspended in the presence of the emanation from radium or thorium, would collect upon it the radioactive decomposition products of the emanation. Elster and Geitel, utilising this fact, exposed a long wire charged to a high negative potential to the air, and then tested it for the presence of radioactive matter.

After the wire had been thus exposed for several hours, it was placed in a closed vessel with a charged electroscope. The latter was discharged much more rapidly than normally, showing the presence of radioactive matter upon the wire, which ionised the gas around the electroscope.

The presence of radioactive matter upon the wire was further shown by rubbing the wire with a piece of leather that had been dipped in ammonia. The leather became quite strongly radioactive. When a negatively charged wire was suspended in air which had remained undisturbed for a long time in contact with the earth, as in certain cases, Elster and Geitel showed that enough radioactive matter was deposited upon the wire which when removed by a piece of leather produced a visible fluorescence in barium platinocyanide when brought near to the leather.

All of these facts point to one conclusion. The radioactive matter in the air comes from the radium emanation. This shows that *radium emanation is present in the atmosphere*. The amount of radium emanation in the air varies greatly in different localities. In certain cases the radioactivity of the air is relatively great, as has already been stated. The amount of radium emanation in the air in some localities is more than a dozen times as great as in other regions. Certain experiments made in northern Norway would seem to show an abnormally great amount of radium emanation in the air in that region.

Since the radium emanation in the air probably comes from radium in the soil, the amount of the emanation in the air in any section of country may be taken as a rough index of the amount of radium in the soil in that region. This is, of course, only an approximate relation, unless frequently repeated tests were made, since the winds shift the air so frequently from one region to another.

Freshly fallen Rain or Snow radioactive.

If the air contains radioactive matter we might expect that some of it would be carried along with objects moving mechanically through it.

Fortunately the means for testing this conclusion are supplied to us by nature. When drops of rain or flakes of snow fall through the atmosphere they might be expected to carry down with them some of the radioactive matter in the air. This has been tested by C. T. R. Wilson in England, and in the case of snow by Allan in Canada. Wilson found that freshly fallen rain showed the presence of quite an appreciable amount of radioactive matter. This radioactivity, however, rapidly decayed. If barium chloride is added to freshly fallen rain, and the barium precipitated by sulphuric acid, the barium sulphate that is thrown down is quite radioactive, showing that the radioactive matter in the water is carried down with the precipitate.

Both Wilson and Allan found that newly fallen snow was radioactive. When a considerable quantity of the snow was melted and the resulting water evaporated, a radioactive residue was left behind. The radioactivity, however, rapidly decayed, as in the case with the freshly fallen rain. All of the above facts taken together leave no reasonable doubt as to the presence of radioactive matter in the air.

Is Matter in general Radioactive?

Having found a number of chemical elements that are radioactive, and having shown that these are radioactive to such different degrees, the question naturally arises, are there not other substances that possess radioactivity? It is possible that there may be a large number of the chemical elements that are feebly radioactive, or all matter might be radioactive to some slight extent. The first experiments bearing upon the broad question were those of Mme. Curie, and these gave negative results. She examined a large number of the chemical elements for radioactivity, and found it manifested only by those already considered. The question in this connection is whether the method employed by Mme. Curie was sufficiently sensitive.

An exactly opposite result has since been obtained by a number of investigators, and especially by Strutt. Strutt, Cook, and others have undoubtedly proved that ordinary matter, in general, is radioactive to a very slight extent, but unquestionably radioactive. Having settled this point, it still remains to determine whether this slight radioactivity is due to the substances themselves, or to radioactive matter deposited in minute quantities upon them. There is, as yet, not sufficient experimental data to decide this point.—Electrical Review, N.Y.

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Nitrates from the Air.

On the occasion of the St. Louis Conference held in 1904 we mentioned during our report of the proceedings the work of Messrs. Birkeland and Eyde in the electrical fixation of nitrogen from the air. Doubts have been cast from all sides on the commercial utility of this process, and the failure of an American company exploiting another process gave support to the statements of dissentients. Meantime the Birkeland process has been giving satisfactory results at Notodden and developments are pending which will establish the business on a thoroughly sound footing, while substantiating its claims to real commercial merit.

The subject has been given prominence to recently by Prof. Silvanus Thompson, whose discourse before the Royal Institution has excited considerable comment. For the benefit of his distinguished audience the Professor had arranged an exhibition on a small scale of the Birkeland process and was able to show the effect of the arcing produced with 20kw. at 4000 volts.

Professor Thompson prefaced his lecture by giving figures which tend to show that in about a quarter of a century hence the production of wheat will have fallen to such an extent below the demand that the wheat-eating sections of humanity will be reduced to starvation. As wheat-eaters are increasing and the extent of the product of wheat-bearing areas is known, the possibilities of such a dénouement are not as remote as may be supposed, and it is upon this assumption that Professor Thompson bases his opinion of the universal importance of the Birkeland-Eyde process.

Sir William Crookes, who sounded the alarmist note in his presidential address to the British Association in 1898, also gave the clue to the means of salvation from the catastrophe anticipated when he said "Starvation may be averted through the laboratory," and this then is the justification for the electrical production of nitrates which shall take the place of those now extracted from the soil in Chili and largely used for fertilizing purposes.

Referring to the products of the process Professor Thompson said :—

Nitric oxide fumes at once absorb a further quantity of oxygen from the unconsumed part of the air and turn to nitric peroxide, and this when treated with water combines to form nitric acid. But nitric acid, valuable though it is, is a most undesirable substance for transportation. It is obviously easy to absorb the acid in caustic alkali, and to produce nitrate of soda. But here two difficulties present themselves. Caustic soda is not a natural product in Norway and would require to be imported for the purpose; and the liquid formed by treating the nitric oxide with water contains nitrous acid as well as nitric acid, so that the product would be a nitrate of soda containing a considerable proportion of nitrate of soda. For some purposes the presence of nitrate would be objectionable, though as recent experiments of Professor Schloessing show, the prejudice against nitrate as a manure is largely unfounded. It was therefore decided to employ lime as the basic agent; and as a very pure limestone can be procured in any quantity in the neighbourhood, it is easy by merely leading the crude acid into vats containing limestone to produce nitrate of lime. So it comes about that the product which the Nitrogen Company of Norway is putting on the market is neither nitric acid nor nitrate of soda, but nitrate of lime. The nitrate of lime is, in proportion to the amount of nitric acid it contains, the equivalent as a fertiliser to nitrate of soda; and for certain kinds of soil the circumstance that lime, not soda, is its basic constituent is a positive advantage. Pure calcic nitrate, moreover, commands a market of its own in preference to nitrate of soda for certain uses in the chemical industry in the manufacture of colouring matters. Very wisely, therefore, the Nitrogen Company determined, in starting their factory at Notodden, that they would confine its operations to the sole production of Norwegian saltpetre—that is, of nitrate of lime.

Professor Otto Witt has publicly stated that, according to his observations, the yield was between 500kg. and 600kg. of anhydrous nitric acid per kw.-year, and that not infrequently higher yields were observed under varying conditions. If we take the lowest figure of 500kg. per kw.-year, and assume the cost of electric power at 0.1d. per unit, this would make the cost of the pure nitric acid (so far as electric power is concerned) £7 6s. per ton, and the nitrate of lime, containing 13 per cent. nitrogen, would cost (in power alone) £4 10s. per ton. To this, of course, would have to be added the additional costs in labour and supervision, together with interest on capital outlay, rents, and the inevitable standing charges. But power, as obtained from the waterfalls of Norway, does not cost anything like 0.1d. per unit. At about half a mile from Notodden is the waterfall called Tinnfos, where some 6000h.p. is applied to a pulp factory. The capital expenditure was under £5 10s. per h.p., and the cost of production is about $\frac{1}{40}$d. per unit. The owners of the pulp factory sell part of this power to the saltpetre factory at about £1 14s. 4d. per kw.-year, or 0.047d. per unit, yielding them a handsome profit. The manufacture of Norwegian saltpetre then calls for nothing save the machinery that is not found ready to hand—air, water, limestone, and electric energy.

TABLE SHOWING VARIETY OF PRACTICE IN THE OPERATION OF PICKLING SOLUTIONS FOR IRON.

(From Electro-chemical Industry.)

MATERIAL TREATED.	PURPOSE.	COMPOSITION OF PICKLE.	TIME.	REFERENCE.
Drawn iron and steel tubes.	Removal of mill scale after annealing.	1 part HCl-39 parts water.	....	Marks.—"The Manufacture of Steel and Steel Tubes."
Cast or wrought iron articles.	Removal of scale.	1 part HCl or H_2SO_4 to 10 of water, to which tar is also added.	....	Brannt.—"Metal Worker's Handbook."
Iron ware.	Preparatory to enamelling.	1 part of H_2SO_4 and 20 to 22 parts of water. 30° to 40° C.	Under 24 hours.	Randau. — "Enamels and Enamelling."
Structural iron.	Removal of scale and rust.	25% to 28% H_2SO_4 hot or	6 to 12 minutes.	Sabin.—"Technology of Paint & Varnish."
		9% to 10% H_2SO_4 cold.	5 hours.	
Sheet iron.	For galvanising.	HCl preferable to H_2SO_4. 1 part acid to 1 part water.	....	Harbord — "Metallurgy of Steel."
Sheet iron.	For tinning (preliminary operation).	Commercial H_2SO_4, 1.6 to 1.74 s.g. diluted by equal amount of water.	....	Harbord — "Metallurgy of Steel."
	(After rolling and annealing.)	Weak solution of H_2SO_4 free from arsenic.	....	Harbord — "Metallurgy of Steel."
Structural iron.	Removal of mill scale for electro-galvanising.	1 part H_2SO_4 to 10 water, or 1 part HCl to 10 water.	5 to 20 hours.	Cowper - Cowles.—"Electrochemical Industry," March, 1903, p. 263.
Boiler plates, tubes and steam pipes.	Removal of scale for inspection.	1 part HCl to 19 water.		British Admiralty specification. *Ibid.*
Rough castings and wrought iron.	For electro-plating.	1 part H_2SO_4 to 4 water.	....	Hawkins.—"The Polishing and Plating of Metals."
Smooth castings and stampings.	For electro-plating.	1 part H_2SO_4 to 10 water.	....	Hawkins.—"The Polishing and Plating of Metals."
Castings with adhering sand.	For electro-plating.	1 part HF to 15 water.	....	Hawkins.—"The Polishing and Plating of Metals."
Iron and steel.	For removing rust.	Pure concentrated HCl.	4 to 20 minutes.	Hawkins.—"The Polishing and Plating of Metals."
Sheet iron.	For galvanising.	1% H_2SO_4 solution.	6 to 8 hours.	Molesworth. — "Pocket Book for Engineers."
Wrought iron	For electro-galvanising.	HCl preferable to H_2SO_4 except for cost.	....	Davies.—"Galvanised Iron."
		H_2SO_4 of 1.85 s.g. diluted by 5 parts water.	20 minutes.	
		HCl of 35 Twaddell diluted by 1 water.	12 to 15 minutes.	
Wrought iron.	For electro-plating.	2% HNO_3 or 8% H_2SO_4 or 2% HCl.	....	Foster. — "Electrical Engineers' Pocket Book."
Cast iron.	For electro-plating.	3% HNO_3 or 12% H_2SO_4 or 3% HCl.		

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Auxiliary Poles for Large C. C. Turbo-Dynamos.

By H. M. HOBART.

In THE design of large continuous-current dynamos for steam turbine speeds it becomes necessary to introduce auxiliary windings in order to obtain satisfactory commutation. Without these provisions it becomes impossible, with fixed brush position for all loads and with carbon brushes, to avoid proportions leading to reactance voltages which would occasion sparking.

The most satisfactory solution from the commercial standpoint consists in the employment of auxiliary poles intermediate between the main poles. These auxiliary poles are furnished with windings carrying the main current, the windings being proportioned to provide a magneto-motive force at any and every load, not only sufficient to neutralize the armature magneto-motive force but to provide a field of sufficient intensity and extent and of suitable direction to approximately neutralize the reactance voltage set up in the armature coils while short-circuited under the brushes.

Such designs afford the best means yet available for securing good commutation in large steam-turbine-driven continuous-current dynamos. The principle is also coming to be widely used in small continuous-current dynamos and motors, not only for high but also for moderate speeds. In cases where heating is the limit of output, and not sparking, such designs are more expensive and less efficient, and their use is not in accordance with sound engineering practice.

Auxiliary commutating poles are the more suitable the higher the speed, voltage, and output. When all three of these factors are high, a design with auxiliary windings will alone permit of a satisfactory result. When all three factors are low, a design with commutating poles would be more expensive and no better as regards commutation or in any other respect than a correct design without them. For intermediate cases a careful preliminary comparison of alternative design is often necessary. For a 750kw., 250-volt, 1,500 revolutions per minute design, auxiliary poles should be employed, as an ordinary design with good commutation is impossible. For 250kw. machines for 250 volts and 1000 revolutions per minute, while designs with commutating poles are much cheaper and more satisfactory, good designs without them are still practicable.

Coming down to 100kw. machines for 250 volts at 1000 revolutions per minute, the advantage which commutating pole designs have over ordinary designs is but slight. At a somewhat lower output or speed there would, for 250-volt designs, be no choice. For still lower outputs and speeds, for 250 volts, the commutating-pole design becomes the more expensive. For a 100 revolutions per minute design, for 250 or even 500 volts, the preferable design would be without commutating poles, even in large capacities. At 200 revolutions per minute and 500 volts, commutating poles are desirable from, say, 400kw. upward, and for 200 revolutions per minute and 250 volts from, say, 600kw. upward.

Of course, such statements can only be general, and the preferable design depends

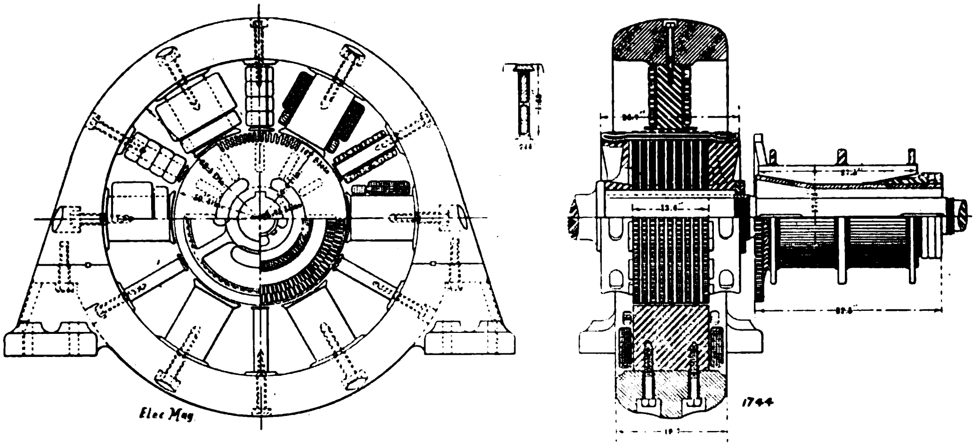


Fig. 1. End Elevation and Section of 1500kw. Turbo-alternator.

very greatly upon the precise conditions for which the machine is to be used. In general, however, when heating and not commutation is the limiting consideration, the cheapest and best design will be without commutating poles, and vice versa when commutation is the limit. Commutating poles are generally preferable to Déri windings on the score of the mechanical superiority and lower labour cost associated with the windings of the former type.

In the following specification and in the diagrammatic sketches in Figs. 1 and 2 are given the rough outlines for the electromagnetic design for a 750kw., 250-volt, continuous-current generator for a speed of 1500 revolutions per minute. This rough design, while in no sense to be taken as a model to be copied, nevertheless serves our present purpose of illustrating the considerations entering into the design of large continuous-current dynamos with reversing poles.

The main problem relates to the design of the commutator. Notwithstanding recent very encouraging progress in the development of improved carbon and graphite brushes and in improved brush-holders, a peripheral speed of thirty-five metres (115ft.) per second is as high as it is yet desirable to go. In order to get sufficient radiating surface to prevent excessive temperature rise, the commutator, as will be seen from the example, is of great length and correspondingly awkward as regards mechanical design, the more especially so with respect to providing internal ducts for the circulation of air. As a compromise between the mechanical and electrical difficulties, a much higher temperature rise than would be preferred has been allowed in this design. The temperature rise will be some sixty degrees centigrade. Some designers would have shortened the commutator by resorting to copper brushes. This, in the writer's opinion, is not advisable. The newer types of graphite brushes indicate very encouraging progress toward lower-friction coefficients and I^2R contact losses, and this progress, when thoroughly verified by time tests, can gradually be followed up by decreased commutator lengths.

Armature.

The core-plates are stamped in one piece from plates not more than 0.5 millimetre thick and are threaded directly on to the shaft, as the required shaft diameter does not permit of an armature spider. The slot conductors are kept in place by wedges which in turn are retained by recesses in the sides of the slot and by binding bands. The end connections are carried on a specially shaped end-plate, which is so curved on its surface as to permit of the binding wire holding the end connections being heaped toward the centre.

Commutator.

The construction of the commutator differs rather radically from that customary for slow and moderate speed designs. The segments are built up with the intervening layers of mica and clamped together. Circumferential mica bands are then placed at the middle and at the two ends, and three steel rings are shrunk on over the mica. The interior contour is then machined and the commutator is secured in place on the shaft by cones forced in by end rings. The external surface is then turned.

Brushes.

The brushes are of carbon or, preferably, of graphite of low contact and radial resistance and high transverse resistance. They are carried in holders of a suitable type to prevent vibration and chattering at the high peripheral speed employed.

Magnet Frame.

The yoke is made from cast iron. This is employed chiefly on account of the greater rigidity and stability thereby obtained as compared with a cast-steel yoke of equivalent magnetic capacity.

Auxiliary Commutating Poles.

The main current of this machine is equal to 3000 amperes. Taking 1000 amperes through a diverting shunt leaves 2000 amperes, which, if carried through the coils of the six auxiliary poles in a single series, would require about five turns per pole, and each turn would be of inconveniently large cross-section. It is also objectionable to use many turns in parallel owing to the difficulty of obtaining good contact at the connections. An alternative would be to put the spools in parallel, but unless very carefully adjusted the different windings would be of unequal resistance, resulting in varying strengths of current in different spools.

To overcome these difficulties the following arrangement of winding has been adopted : each spool is sub-divided into four sections wound with five and one-half turns of copper strip. The details of the winding scheme are shown diagrammatically in Fig. 2. The winding is arranged in four parallel circuits with 500 amperes per circuit. Each circuit contains one section of winding on each pole, or thirty-three turns in series. By this arrangement the convenience of parallel winding is obtained without incurring the liability of having varying strengths of field on the different commutating poles, since any inequality in the current in one section is shared by all the poles.

Designing Data (abridged).

Number of poles	6
Kilowatts output at rated load	750
Speed in revolutions per minute	1500
Frequency in cycles per second	75
Terminal voltage	250
Amperes output at full rated load	3000

Reversing Pole Core.

Length of pole face parallel to shaft ..	9.5in.
Length of pole arc..	2.9in.
Radial depth of air gap	0.275in.
Width of magnet core parallel to shaft	5.7in.
Width of magnet core at right angles to shaft..	2.56in.
Cross-section of core	13.2 sq. in.

Electrical Data.

Number of face conductors	324
Number of slots	162
Number of conductors for slots	2
Style of winding	6-circuit double

(A double winding was adopted in order to obtain a sufficiently large number of slots per pole and to obtain a more convenient dimension of armature conductor.)

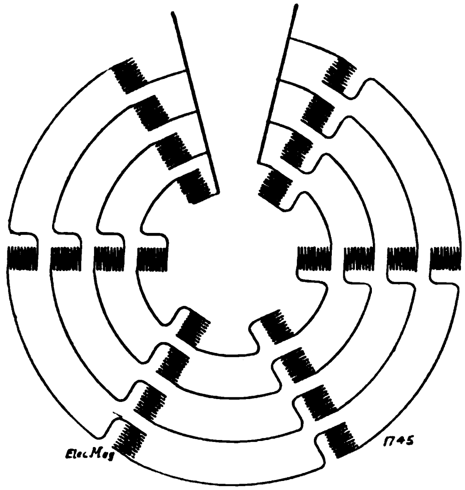


FIG. 2. DETAIL OF AUXILIARY WINDING.

Number of circuits through armature	12
Total amperes from commutator	3000
Amperes per circuit	250

Commutator Calculations.

Commutator diameter	17.75in.
Number of segments	162
Thickness of segment + insulation at periphery	0.344in.
Total length of commutator	27.5
Number of sets of brushes	6
Number of brushes per set	12
Width of brush	1.16in.
Length of arc of contact	1.16in.
Contact surface per brush	1.35in.
Amperes per sq. in. of brush contact surface	61
Peripheral speed of commutator	35.4
Reactance voltage	15.5

Reversing Pole Winding.

Number of sections of winding	4
Turns per section	5 1/2

Dimensions of conductor	1.18 × 0.177in.
Cross-section of one turn	0.42in.
Watts lost per section	57
Weight of copper per spool (for four sections)	65lb.

Total Losses.

Total constant losses	22,782
Total variable losses	16,442
Total	39,224
Commercial efficiency at full load	95.2%

Weights of Effective Materials.

Armature copper	365lb.
Commutator copper	1210lb.
Shunt spool copper	790lb.
Series spool copper	258lb.
Reversing pole spool copper	352lb.
Armature laminations	1150lb.
Magnet cores, cast steel	1760lb.
Reversing pole cores, cast steel	187lb.
Yoke, cast iron	6500lb.
Total weight of effective material ..	12,572lb.

Costs.

Total cost of effective copper	£134 8 0
Total cost of effective iron	56 12 0
Total cost of effective material	191 0 0
Total cost per kilowatt .. 5.15 shillings	($1.275)

As the exciting coils on the auxiliary poles are mainly required for overcoming the armature magneto-motive force of 6550 ampere turns per armature pole, one cannot save much copper by employing low densities or short air-gaps in the auxiliary circuits. Especially as regards the air-gap, a deep gap will increase to a much less extent the reactance voltage of the short-circuited coils due to the proximity of the magnetic material of the pole extremity. A deep air-gap will also tend to reduce the core loss and also the noise. Of less, but still of considerable importance, is the fact that a deep air-gap under the reversing poles will, by reason of the magnetic material of the pole shoe being further removed from the armature conductors, increase the magnetic reluctance of the inductive iron paths round the short-circuited armature coils, and will thus slightly reduce the reactance voltage and in turn the dimensions of the reversing pole. The length of the pole arc of the auxiliary pole is chosen such that during the whole period of commutation a coil shall be moving in the auxiliary field.

It is important that the coil shall be moving in a sufficient field at the moment when its commutator segments are leaving the brushes. The pole arc should cover as many slots as are carrying conductors simultaneously short-circuited by the brush, and it is safer to have a larger pole arc than this to allow for any distortion of the auxiliary field which may occur with varying load. An additional allowance is also necessary when there are several segments per slot, as the true diameter of commutation is then constantly swinging back and forth through a small arc.

The total ampere turns required on the auxiliary pole are made up of a number equivalent to the magneto-motive force of the armature, and a number of ampere turns sufficient to send the flux across the auxiliary air-gap and round the auxiliary magnetic circuit, *i.e.*, through the pole core and teeth immediately under the pole face. As this saturation component of the ampere turns, in the design here given at any rate, is comparatively small compared with the armature reaction component, the total ampere turns on the pole will not be much increased by saturating the pole core to as high a limit as possible, thus reducing the cross-section of pole to a minimum, and consequently the peripheral length of the winding and obtaining a minimum weight of copper. Such high saturation has, of course, the objection that the reactance voltage increases directly with the output, and so should also the reversing field from the auxiliary pole, but it must be remembered that exact equality need not be maintained at all loads, since a range of residual voltage from one or two volts negative to one or two volts positive, *i.e.*, a total range of, say, three volts, will not suffice to occasion sparking.

The resistance of the diverting shunt is finally adjusted during actual test to such a value as to obtain good commutation at all loads.—Abstracted from Electrical Review, New York.

An Automatic Multi-Stage Turbine Governor.

By HENRY F. SCHMIDT.

In the governing of multi-stage turbines of the impulse type, such as the Curtis, Rateau, &c., there are three general ways of accomplishing the variation of steam supply in accordance with the load.

The first, used by Rateau, is to simply throttle the steam, thus cutting down the supply as well as the pressure, which means a loss of energy, since the reduction of pressure means a smaller temperature range and consequently a lower efficiency at part load than at full or overload.

The second, used by Curtis and others, in which the reduction of energy supplied is obtained by closing one or more nozzles, thus reducing the area for the flow of steam, but, at the same time, allowing the steam to work with the same degree of expansion at full as at part load, and, consequently, equal efficiencies at all loads. In the Curtis turbine, the area of the nozzles is changed only in the first stage to meet the change of load. The area, or what is the same thing, the number of nozzles of the second, third and fourth stages, except in a few machines in which the later stages are also controlled by the governor, remains constant throughout all changes of load. As a result, the pressure in the latter stages in which the area of the nozzles remains unchanged, will decrease, since the area at part load will be larger than is required to pass the steam which is now admitted through the smaller number of nozzles open in the first stage. The result is that not any of the nozzles are operating at their designed pressures, and, as is shown by Stodola, there is a serious loss of energy at the mouth of the nozzles because of steam shock. The latter nozzles, moreover, do not give the steam the velocity that it should have, and, therefore, most of the work is, at part load, performed by the first stage wheels, the others, revolving in a partial vacuum, acting at a very light load, as a drag rather than performing any actual work.

The third method, of which that of Schultz may be taken as an example, is like that just described, except that the number of nozzles in all the stages is varied to suit the load, the main governor doing all the work of regulation. The method of changing the number of nozzles in action is by turning rings in front of each ring of nozzles, each movable ring having a number of holes in it equal to the number of nozzles, but each hole of a different length, so that turning the ring around the distance equal to one nozzle opening shuts one nozzle, &c. This method is, however, inconvenient, since the entire load of moving all the rings, the number of which will correspond to the number of stages in the turbine, will come on the governor, which must necessarily be of a very powerful design. It is also necessary to employ a mechanism similar to that used on water wheels, such as the Denis used by Rateau. Such mechanisms are sluggish in their action and result in less close regulation than is obtainable in other types.

To overcome these difficulties the writer has devised a new type of governor, which is shown diagrammatically in the accompanying illustrations (p. 134), and which is based upon the following primary considerations of steam turbine governing.

First, in order to have a uniform efficiency at all loads, it is necessary that the expansion ratio in the turbine remain constant; that is, the temperature range must be constant.

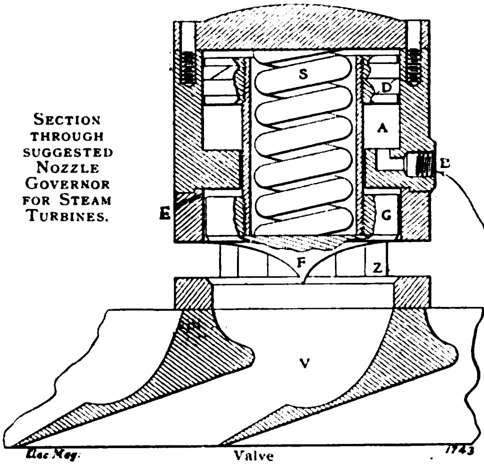
Second, the nozzles in each stage must be operated between the specific pressures for which they were designed, in order that the issuing jet will have the velocity suitable to the bucket angles of the wheels of its stage.

Third, for instantaneous governing for change of load, it is absolutely necessary that a change in the energy delivered to the turbine shall determine the immediate output of the turbine. This evidently cannot be accomplished by the Curtis method of only closing the first stage nozzles, since there is quite a large volume of steam in the shell of the various stages which will expand down to the condenser pressure, and do a considerable amount of work after the governor has acted. Hence, if the turbine is so constructed that it contains any considerable volume of steam, the areas in the various stages should be decreased at the same time the first stage nozzles are closed, in such a manner that the weight of steam passing through the turbine shall be the same at all points.

These considerations led the writer to the adoption of the method of the accompanying drawing (p. 134), which represents it as applied to one of the nozzles of a large Curtis turbine.

In this figure the part marked "valve" is located entirely within the turbine shell, and directly over the nozzle which it controls, and the "controller" is located outside of the turbine. This is used only for the control of the stages other than the first, which is controlled by the governor proper, its only object being to maintain the pressure in each stage practically constant. Its operation is as follows:

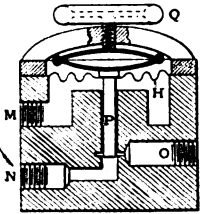
The openings B and N are connected by a small pipe, and the openings M and O are connected to the shell of the stage in which the pressure is to be controlled, and in which the valve is located, and the main steam line respectively.



Section through suggested Nozzle Governor for Steam Turbines.

Now assume that the pressure in the shell has been low, and the valve G resting on its seat Z. In this case the pressure of the atmosphere on top of the diaphragm H would be greater than that of the shell pressure on its under side, and hence the small auxiliary valve B would cover the port. Now if the shell pressure were to increase, the valve P would be raised and high pressure steam admitted to the space under the piston D, the valve G would be raised from its seat, allowing steam to flow through the nozzle V, and the pressure in the shell would be slightly decreased. The reverse action, when the pressure in the shell becomes too small, that is, when too many nozzles are open to satisfy the first stage nozzle conditions, is easily evident, since then the atmospheric pressure would close the auxiliary valve, and then the spring S would close the valve G. The opening and closing of valves will always be such by this arrangement that the pressure will remain nearly constant. The function of the hand wheel and screw Q is to adjust the action of the valve to the desired pressure.

It will now be evident that this form of governor would exactly meet the conditions which were given for a perfect multi-stage governor, and since the pressure in all the stages is kept constant, the energy which is transmitted to the moving wheels will be directly proportional to the load indicated by the first stage governor, since the weight of steam passing all points of the turbine at any instant is the same. The application of this principle to an actual turbine would no doubt be radically different in construction, and, further, the number of valves which would be required in a large turbine would be prohibitive, and for that reason the adoption of "group governing" would doubtless have to be resorted to; that is, to have one of these "controllers" for a group of nozzles, which would give very good approximation to the desired results.—Abstracted from Power.



Controller

* * *

Frequency Indicators.

Of all electrical quantities, one of the most difficult to measure accurately is the frequency of an alternating current. The earliest attempts were mostly based on the variation of the current passed by a highly inductive circuit at different frequencies. That such a system must be most unreliable will be at once clear when it is remembered that this current will depend almost as much on wave-form as on frequency. Some makers have endeavoured to get over the difficulty by providing their instruments with a resistance which is variable from the outside of the case, so that after the indicator has been installed the reading can be adjusted to suit the particular wave-form of the generators on which it is to be used. This solution, unfortunately, assumes that the wave-form of all the machines in a station are identical, which assumption is, of course, hardly ever justifiable.

Another arrangement, and one which has been applied with considerable success, consists in coupling an ordinary tachometer to either a small synchronous motor or else an asynchronous motor of sufficient size to run with practically constant slip. The objection to the synchronous motor is that it will not start, but this defect can be got over by running up to speed as a commutated motor, and switching over when the rotor is in step. Probably the greatest objection to the system lies in the uncertainty of tachometers, and in the fact that a continually running motor is bound to require a certain amount of attention, and moreover the cost of the arrangement is considerable.

A completely different principle, and one which appears destined to supersede all others, was originally suggested by Mr.

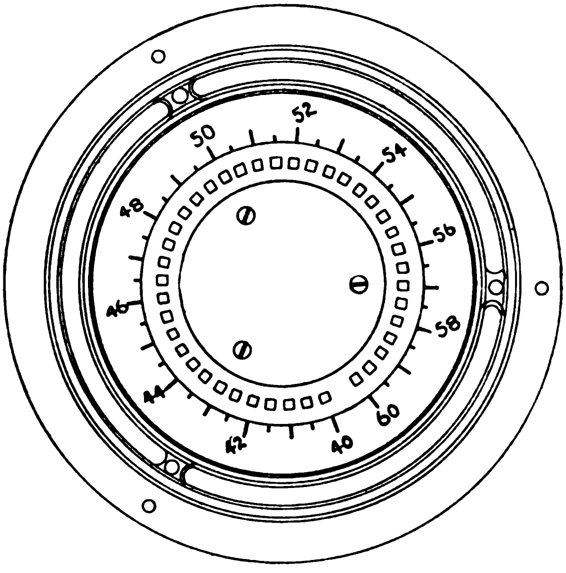


FIG. 2. FRONT VIEW OF DIAL OF REED FREQUENCY INDICATOR.

Albert Campbell. It consists in subjecting a tuned reed or reeds to vibrations of the frequency to be measured. When the free period of vibration of the reed is the same as that of the vibrations applied to it, the amplitude of swing will be enormously increased, owing to resonance. That is to say, each impulse will be applied to the reed at precisely the moment it is required, in order to still further increase the swing.

Figs. 1 and 2 show another modification of such an instrument in section and elevation.

The electro-magnet, as will be seen, is circular in form, and the reeds are arranged round it, and being of steel are attracted at their upper ends, and thus kept in vibration. It will be clear that the tongues are attracted once in each half period, that is, twice per cycle. A very simple method of doubling the range thus suggests itself, which consists in providing the electro-magnet with a second winding through which a direct current can be sent. If the ampere turns of the two windings are the same, it will be seen that one half of each wave is wiped out, while the other half is doubled in magnitude, and thus the reeds are attracted only once per cycle instead of twice, that is, they respond to double the previous frequency.

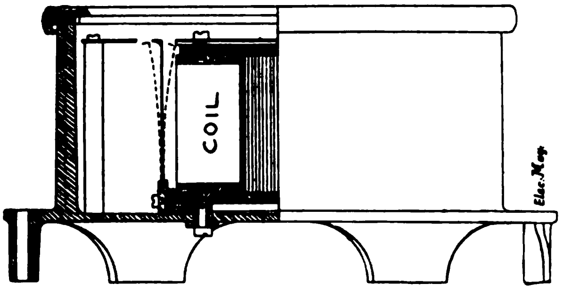


FIG. 1. SECTION THROUGH REED FORM OF FREQUENCY INDICATOR.

The sharpness with which a particular reed is picked out is quite extraordinary. In practice, one reed usually corresponds to each half cycle, and it is then easy to estimate quarter cycles with accuracy. It might be thought that the tongues would deteriorate with the continual bending and might even break off. In practice, however, no trouble whatever is found from this cause. In fact, numbers of reeds which have been tested after being in continual use for years, have been found to possess identically the same time of swing as when first installed.

A successful form of frequency indicator, working on an analogous though slightly different principle, has been introduced by Frahms. This instrument, like that just described, is provided with a number of tuned tongues, but in this case, instead of each being set separately in vibration by an electro-magnet, they are all fixed to a common support, which is vibrated by the electro-magnet. Thus, the impulses in this case are mechanical rather than magnetic. In other respects the arrangement is similar to the one just described.—K. Edgcumbe, before the Junior Institution of Engineers.

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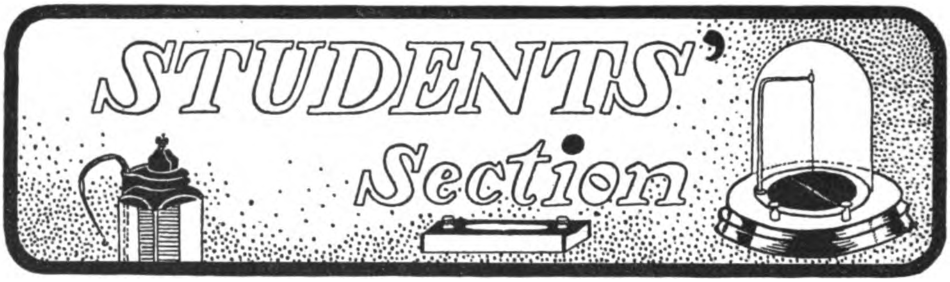


STUDENTS' Section

Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Experience on the Road.

By W. F. LAMME.

My first experience on the road was as a "trouble" man. To be a successful "trouble" man it is necessary to have some knowledge of the design and characteristics of the apparatus against which complaints are made.

Troubles with apparatus can be divided into two classes—real troubles and troubles imagined; that is, which do not really exist. The latter, the imagined troubles, need not worry the road engineer farther than to think out and present proof that they do not exist in fact. Sometimes a local engineer has imagined difficulties, but before the discovery of his position he has committed himself, and in order to "make good" he must adhere to his statement that something is wrong. In many cases it is well for the road engineer to act in a diplomatic manner and give the local engineer an opportunity to withdraw gracefully without injuring his standing with his company.

When the trouble is a real one, then it is wise for the engineer to use caution. Most troubles, before they reach the point where an engineer is sent out, have gotten the customer in an unfriendly mood, and when the manufacturer's engineer arrives upon the ground, he finds himself received, in many instances, in an abrupt manner, and, in most cases, coldly. The manager may ask you for an opinion before you have looked over the case, and may show displeasure if you cannot give him an immediate answer. He turns you over to his engineer, who, in order to show his loyalty to his company, or because he too is irritated at the state of affairs, gives you an exaggerated and misleading description of the situation. Under the above conditions, and they are numerous, it is best for the road engineer to maintain silence, listen to all that is said, but make no judgment in his own mind until he has made investigation for himself.

One of our salesmen sold an alternator. Of the operation of this alternator evidently a very glowing description had been given to the purchaser. The alternator was of the well-known compound type, belted to a high-speed engine, with a flywheel governor. The alternator was of standard make and all its characteristics were well known. The load was lighting, therefore nominally non-inductive. The exciter was of ample capacity.

The report on this installation stated that at times great difficulty was experienced in keeping up the voltage; the exciter was much overloaded and two exciter armatures had been damaged; several electrical engineers had experimented upon the case and had secured no satisfactory results, therefore it was not welcome news to be designated for the job. However, the salesman and myself visited the plant and, as usual, met with a chill. The plant was started and everything ran well; the alternator held voltage with a large margin on the rheostats and the exciter was quite cool to the hand. The alternations were about correct, the engine running at, approximately, 250r.p.m.

Retiring to await developments, we returned in about an hour. Conditions had now changed. The alternator could barely hold voltage, with all the rheostats out, and the exciter, labouring under a heavy overload, was quite hot, but I noticed a different hum from that at the start of the machinery. This led me to take speed. I found the engine now running not at 250 but at 217r.p.m. This explained everything. There was a defect in the engine governor which caused the speed to drop at a certain load and to remain there. After this defect was remedied the engine held speed and the electrical apparatus proved to be in every way satisfactory.

The centrifugal pump driven by an electrical motor, is sometimes a source of annoyance, and the motor—"the mysterious thing"—receives the blame. The purchaser will tell you that anyone can calculate the power required to drive a pump, but the electric motor is an incomprehensible piece of apparatus, and therefore must be the part at fault. One installation driven by a 10h.p. direct connected motor should have required about 6h.p., but the motor ran so hot that frequent shut downs were necessary to permit the motor to cool off: actual tests proved this pump took, approximately, 18h.p., and that two-thirds of the required power was expended in churning water. This pump was adapted for a much higher head than that under which it was operating.

Four large alternators in a certain plant would not maintain voltage beyond a load of two-thirds of the capacity of the units. Upon meeting the manager he desired a clear explanation of the difficulty before we had investigated the matter at all. Of course, an intelligent reply to his questions was impossible, and he would not accept a statement that we did not know as yet, but took the view that we were hiding something.

Proceeding quietly with the work, taking a saturation and regulation curve, according to the methods in vogue at that time, we soon discovered that something was preventing the passage of the magnetic flux through the armature coils. This of course directed attention to the air gap and the pole tips. It was noted that the field bobbins were at a distance back from the tips and that the tips were unusually close together; acting upon the theory that the lines of force must be held in and driven through the armature iron, we dropped the coils close to the armature, and the immediate effect was that we could carry 25 per cent. more load with maintained voltage than before, but still the alternator was not up to the guarantee, so to strengthen the pole tips still more, the back fourth of the field bobbins was cut out and the field current was increased 25 per cent. This accomplished the result desired, and the puzzle was solved, but our troubles were not yet over. Going to the manager we explained that the trouble lay in the field bobbins and we wished to return them, one set at a time, to the factory to be changed, but he, thinking he had not been treated rightly, denied the favour, at the same time acknowledging that the machine was not satisfactory nor accepted by him. A survey of the situation brought our erecting engineer to the conclusion that this was all a case of bluff and trying to get even with the company; therefore it was resolved to strip one machine that night, which was done, and a complete set of bobbins was out of the plant and in a car before daylight the next morning.

Of course, "blue smoke" rolled about our heads the next day, but after the return of the bobbins from the factory and the machine was put into service again it was so satisfactory to the operators that the manager gracefully acknowledged that he had been beaten.

In a selling office much "charity" and "missionary work" become necessary. For example: A customer reports that his motor is burnt out; an investigation shows, perhaps, that a fuse is blown, or the power is off the circuit; another reports his motor is grounded, which means he had a static discharge coming from the belt.

Recently a customer thought something was wrong because the voltage on a compound direct-current generator increased when the load came on instead of decreasing. He had always been used to the voltage decreasing with the increase of load, and any other condition he reasoned to be wrong.

A party had a two-phase motor operated on a two-phase three-wire system; it became necessary to take this motor down and reinstall it in another place, but in connecting up again the common wire was put in one side; of course the motor operated badly, and after much worry and many sleepless nights, the manufacturer was called upon for aid. A few minutes' work put him right, and the man showed unmistakable relief and joy.—Electric Journal.

HUNDREDS OF STUDENTS
obtained the Electrical Magazine last year on our special terms. Why don't you procure it in the same way? P.C. for all particulars.

"The Durable Satisfactions of Life."

Part of an Address by CHAS. WM. ELIOT.

For educated men, what are the sources of the solid and durable satisfactions of life? That is what I hope you are all aiming at—the solid, durable satisfactions of life, the satisfactions that are going to last and grow. So far as I have seen, there is one indispensable foundation for the satisfactions of life—health. A young man ought to be a clean, wholesome, vigorous animal. That is the foundation for everything else, and I hope you will all be that, if you are nothing more. We have to build everything in this world of domestic joy and professional success, everything of a useful, honourable career, on bodily wholesomeness and vitality.

This being a clean, wholesome, vigorous animal involves a good deal. It involves not condescending to the ordinary barbaric vices. One must avoid drunkenness, gluttony, licentiousness, and getting into dirt of any kind, in order to be a clean, wholesome, vigorous animal. Still, none of you would be content with this achievement as the total outcome of your lives. It is a happy thing to have in youth what are called animal spirits—a very descriptive phrase; but animal spirits do not last even in animals; they belong to the kitten or puppy stage. It is a wholesome thing to enjoy for a time, or for a time each day all through life, sports and active bodily exercise. These are legitimate enjoyments, but if made the main object of life, they tire. They cease to be a source of durable satisfaction. Play must be incidental in a satisfactory life.

What is the next thing, then, that we want in order to make sure of durable satisfactions in life? We need a strong mental grip, a wholesome capacity for hard work. It is intellectual power and aims that we need. In all the professions—learned, scientific, or industrial—large mental enjoyments should come to educated men. The great distinction between the privileged class to which you belong, the class that has opportunity for prolonged education, and the much larger class that has not that opportunity, is that the educated class lives mainly by the exercise of intellectual powers and gets therefore much greater enjoyment out of life than the much larger class that earns a livelihood chiefly by the exercise of bodily powers. You ought to obtain here, therefore, the trained capacity for mental labour, rapid, intense, and sustained. That is the great thing to get in college, long before the professional school is entered. Get it now. Get it in the years of college life. It is the main achievement of college life to win this mental force, this capacity for keen observation, just inference, and sustained forethought, for everything that we mean by the reasoning power of man. That capacity will be the main source of intellectual joys and of happiness and content throughout a long and busy life.

But there is something more, something beyond this acquired power of intellectual labour. As Shakespeare puts it—"The purest treasure mortal times afford is spotless reputation." How is that treasure won? It comes by living with honour, on honour. Most of you have begun already to live honourably, and honoured; for the life of honour begins early. Some things the honourable man cannot do, never does. He never wrongs or degrades a woman. He never oppresses or cheats a person weaker or poorer than himself. He never betrays a truth. He is honest, sincere, candid, and generous. It is not enough to be honest. An honourable man must be generous; and I do not mean generous with money only. I mean generous in his judgments of men and women, and of the nature and prospects of mankind. Such generosity is a beautiful attribute of the man of honour.

How does honour come to a man? What is the evidence of the honourable life? What is the tribunal which declares at last—"This was an honourable man"? You look now for this favourable judgment of your elders—of parents and teachers and older students; but these elders will not be your final judges, and you had better get ready now in college to appear before the ultimate tribunal, the tribunal of your contemporaries and the younger generations. It is the judgment of your contemporaries that is most important to you; and you will find that the judgment of your contemporaries is made up alarmingly early; it may be made up this year in a way that sometimes lasts for life and beyond. It is made up in part by persons to whom you have never spoken, by persons who in your view do not know you, and who get only a general impression of you; but always it is contemporaries whose judgment is formidable and unavoidable.

Live now in the fear of that tribunal—not an abject fear, because independence is an indispensable quality in the honourable man. There is an admirable phrase in the Declaration of Independence, a document which it was the good fashion of my time for boys to commit to memory. I doubt if that fashion still obtains. Some of our public action looks as if it did not. "When in the course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth the separate and equal station to which the laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation." That phrase—a decent respect—is a very happy one. Cherish "a decent respect for the opinions of mankind," but never let that interfere with your personal declaration of independence. I have said begin now to prepare for the judgment of the ultimate human tribunal. Look forward to the important crises of your life. They are nearer than you are apt to imagine. It is a very safe protective rule to live to-day as if you were going to marry a pure woman within a month. That rule you will find a safeguard for worthy living. It is a good rule to endeavour hour by hour and week after week to learn to work hard. It is not well to take four minutes to do what you can accomplish in three. It is not well to take four years to do what you can perfectly accomplish in three. It is well to learn to work intensely. You will hear a good deal of advice about letting your soul grow and breathing in without effort the atmosphere of a learned society, or place of learning. Well, you cannot help breathing and you cannot help growing; those processes will take care of themselves. The question for you from day to day is how to learn to work to advantage, and college is the place and now is the time to win mental power. And, lastly, live to-day and every day like a man of honour.

We want Contributors

to our Students' Debating Society as represented by this Section.

Our appeal was made in November last, and we refer readers to it for details of the scheme.

Electrical Transmission of Pictures.

By W. M. MARCHANT.

Many attempts have been made to transmit pictures to a distance by electrical means, but have hitherto not met with much success. The following suggestion, based on the discovery in 1873 by J. E. Mayhew that the resistance of selenium is greatly diminished by exposure to light, may be of some interest to readers of the Students' Section. The transmitter is shown in Fig. 1, where A is a camera with the usual ground-glass screen at back. This screen is ruled with very fine horizontal black lines. Behind this are two double grooved pulleys made of ebonite, P and P_1, on which circulate two endless copper wires. Between these wires two small selenium resistances are so fixed that one begins its downward journey immediately the other completes it. These are connected by means of two brushes which press on the wires to the primary winding of a small transformer through the battery B. The resistance of the primary must be kept very low for reasons which will afterwards become apparent. The secondary terminals are connected to line and earth as shown. The pulleys on which the wires circulate are rotated by clockwork and are also given a horizontal motion by means of a spiral thread and feed nut. The receiver is constructed as follows. Round an iron cylinder, whose circumference is equal to the depth of the ground-glass plate, is wrapped a piece of paper, prepared by immersion in a solution of iodide of potassium, starch and water, an iron stylus presses on the paper. The cylinder is caused to revolve and the stylus given a horizontal motion as in a phonograph. The stylus and cylinder are connected to terminals, and these to line and earth. The action of the apparatus is as follows: The selenium bell, in its journey past the ground-glass screen, continually changes its resistance, owing to the varying intensity of the light, corresponding to the lights and shadows of the picture falling upon it. This causes

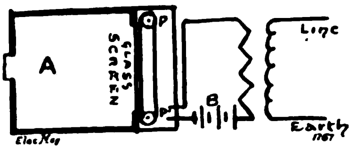


Fig. 1.

a fluctuating current to pass through the primary of the transformer, which, acting by induction on the secondary, causes a current of varying intensity to flow to line. At the receiving end the current, acting electrolytically on the chemically prepared paper, traces a fine blue spiral line, the colour of which varies in depth according to the amount of current passing at the time. By these means a picture the reverse of the original will be produced, from which a positive could be printed in the usual way.

From Professor to Student.

I should be much obliged if you would give me a method of measuring capacities and impedances with the differential receiver.

The following simple arrangement requires continuously variable standards of capacity and inductance. A parallel circuit is arranged one branch of which consists of half the winding of the differential receiver connected in series with the unknown capacity (or self inductance), the other branch being made up of the remaining half of the receiver winding joined in series with the variable standard of capacity (or self-inductance). Alternating currents (say, from a small induction coil) are sent through the parallel circuit, and the variable standard is adjusted until the sound in the receiver is reduced to a minimum. The unknown capacity (or inductance) is then equal to that of the standard.

I am disappointed to find that Whitworth Scholarships are not tenable by electrical engineering students, as I am studying for that profession at the Central Technical College. I should be much obliged to you if you could let me know through your paper whether there are any scholarships tenable by such students.

In addition to a number of entrance scholarships offered to students at the Central Technical College, there are a few others, full particulars of which our correspondent can readily obtain by applying to the secretary of the college. There are further a number of scholarships—the Salomons and David Hughes scholarships—awarded to students of the Institution of Electrical Engineers. By writing to the secretary of the Institution, 92, Victoria Street, S.W., our correspondent can obtain all necessary information regarding these scholarships.

The following are from the Electrical World:—

Please give me the dimensions for a spark coil large enough to operate wireless telegraphy outfit for a distance of one mile overland.

At least a 6in. spark coil should be used. A coil of this size may have the following dimensions: Length of core, 12in.; diameter of core, 1⅛in.; primary coil should have two layers of No. 12 B. & S. copper wire, the secondary coil should be made up of 7 pounds of No. 36 B. & S. copper wire; the core should be made of No. 22 B.W.G. soft iron wire; the condenser for the coil should have 60 sheets of tin-foil, each 10in. by 5in.

Why should a coil on an armature burn out when the two commutator segments to which the coil is connected are short-circuited?

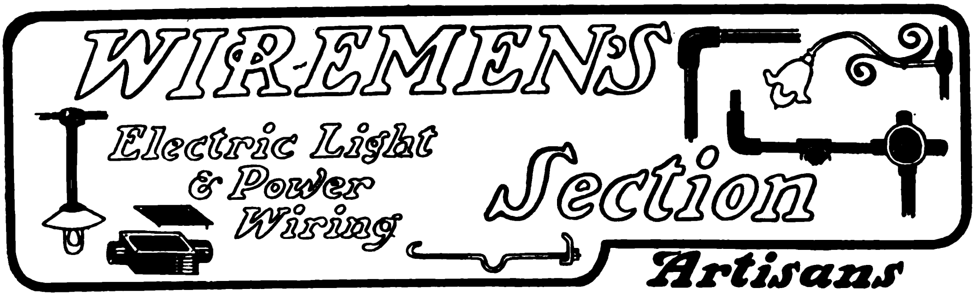
The coil, segments and the short-circuit between the segments form a complete circuit having a low resistance. The sides of the coil which are on the armature cut across the magnetic lines of the pole-pieces and have e.m.f.'s set up in them. Since the resistance of this closed circuit is very low, it is only necessary to have a low e.m.f. set up in the active portion of the coil in order to force a very large current through the coil and the two short-circuited commutator bars. The heating action of this large current is usually sufficient to burn out the coil.

How may I cut out a damaged coil from an armature?

Disconnect the damaged coil from the commutator and after cutting off the leads insulate the exposed parts with tape. Then connect the bars to which the leads of the damaged coil were connected with a wire, or jumper, as it is commonly called, of the same size as that used in the winding. To remove the coil entirely it will be necessary to cut the band wires or remove the wedges, and raise a sufficient number of leads and coils to permit the removal of the defective coil, after which a new coil may be put in place.

Kindly inform me as to the principle of operation of the Tirrill regulator.

The automatic potential regulator devised by A. A. Tirrill rapidly opens and closes a shunt across the generator field rheostat. The regulator has a main control magnet and relay; the former taking power from the busbars or from potential wires brought back from the centre of distribution, and operating the main contacts. By means of a spring, the magnets are arranged just to open and close these contacts at the desired voltage. By this means one of the differential windings of a relay is opened and closed, thus causing a simultaneous opening and closing of the relay contacts which throws in and out the field rheostat.



WIRE-MENS Electric Light & Power Wiring Section Artisans

Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON.

(Continued from p. 57.)

OUR fifth item is a serious one, and has many causes. Armature heating means trouble, and trouble is a nuisance.

Firstly, take means to prove that the heating is an armature fault and not due to transmission from some other source. This can be readily ascertained by looking for higher temperature elsewhere. Examine field coils, bearings, and commutator. Next go over brush position. Although sparking is often caused by faulty brush position, it must not be assumed that this works both ways, as on some machines an error in that direction has a different effect. It will be found in many cases that the only sign that the brushes require adjusting is that the whole armature heats up.

Presuming that all is correct, it follows that other signs of defect must be looked for. The short circuiting of an armature coil will cause heating, but as previous notice of that has been taken under the heading of failing to generate without outside currents we can pass same over here.

Take it that all other parts keep cool, and only the armature gets hot with sparking on the commutator, you are trying to get a quart out of a pint bottle. Reduce the load on dynamo and book an order for a larger machine.

Again, should the whole of the armature become heated when running on light load, and when meter readings are higher than they should be under such conditions, it may safely be assumed that an armature coil has been reversed. The effect of this is to create subsidiary internal currents in the armature and considerable heat. To trace this out secure a dozen dry cells or an equivalent, and send a current through each coil. While doing this hold directly over the coils a small pocket compass. Immediately you arrive at the reversed coil the compass needle will turn in the opposite direction. Connect up correctly and start up again.

If when starting up your machine you find that it taxes your engine and that the armature gets hot, also giving off a strong smell, your generator has been attacked by damp, and prompt measures are necessary. If it is possible remove the armature and send to be dried. Only a firm of manufacturers can do this. Should you be in too much hurry for this the following method may be adopted. But great care must be taken.

First procure a resistance frame and place in series with the shunt, provided you have not a shunt regulator sufficiently large for the purpose. To ascertain this take a reading of the shunt current under normal conditions. This must then be reduced to 5 per cent. of whatever the reading may be. Connect armature leads, putting an ammeter in circuit. Start up your engine and allow about double the rated current to flow. This will dry out the armature in five or six hours. But it is a sort of last resource and electricians are advised not to adopt this method if same can be avoided.

It is imperative that a dynamo should be run at its proper speed. Should your engine be too slow it follows that you will endeavour to raise the voltage by increasing your exciting current in the fields. The result is an enormous increase in internal currents. These, usually called eddy currents, are always present and are a basis of calculation in designing. To increase them means to heat the armature core. Your fields would likewise heat up owing to excessive current passing.

As these currents cannot continue long without complete breakdown great care should be taken to obtain sufficient speed for the dynamo.

It may be taken that nearly the whole of the foregoing remarks on d.c. generators apply to d.c. motors as well. The faults, their causes and cures, arise in both cases, but motors have many things to add. Following the points described the principal difficulties the electrician will meet with in the installation and upkeep of d.c. motors may be taken as—

1. Failure to start.
2. Sparking.
3. Heating.
4. Speed incorrect.
5. Minor faults.

The first fault is one constantly occurring, and ofttimes compels us to look at the machine and—well, pray for it. It is a point for regret that the universal ignorance of the lay mind as to electrical machinery is frequently the cause of much annoyance. In the hands of non-technical men motors get some rough handling when being moved from place to place. As an instance, one day last week the writer observed a 7h.p. motor being carried into a shop by four men. It had been removed from a van, and these sensible individuals had discovered a very easy way to carry it. Two of them seized the pulley end. At the commutator end the brush leads had been pulled through the frame and a piece of iron barrel slipped through them, throwing the whole weight of the machine on to the connections.

But putting aside this description of damage, the most usual causes for a motor remaining stationary may be taken as quite simple affairs.

First ascertain that all fuses are intact and switches closed. Go to your motor and rotate the armature by hand. If this can be done with ease, it will probably be found that it is accompanied by great sparking. Go over all connections, and be sure that they are all correct. Should these be wrong, that is, the fields are in opposition to each other, connect up properly. To find that this is the fault take all load off the motor and start up. It will race. Should all connections be in order, then the fault is most likely a break in the field windings, and same must be located and repaired or a new coil inserted.

If, however, there is a "hang" on the armature when an attempt is made to revolve it—*i.e.* it will only turn in jerks—it is an armature fault, and the broken coil or coils in the armature windings must be traced out and repaired.

Should there be current in both field and armature, then your fault is mechanical, not electrical. Try all bearings, to see that none have seized. Go over the load and see that you are not asking too much from motor.

The cause of failure to start up, presuming all above points are in order, must be looked for elsewhere. Examine starter or regulator carefully, and repair any broken connections. Should there be nothing here, and current is reaching the machine—sell it and buy a motor.

Next let us take sparking. All the references made to this trouble in connection with d.c. generators applies equally here. In nine cases out of ten it is merely wrong brush position. Failing this, reckon up the load and see if motor is overtaxed. Examine all bearings for excessive friction.

With a motor that has been running for some time it may be found that the commutator has become ridged. In connection with this take particular care that the brushes

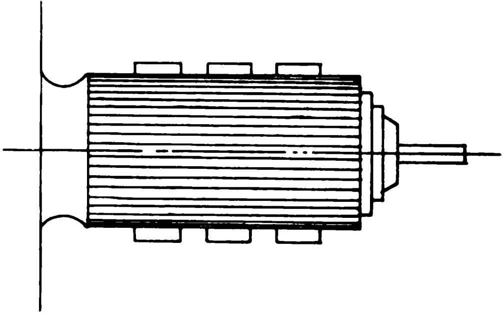


Fig. 19. How Motor and Dynamo Brushes should not be set.

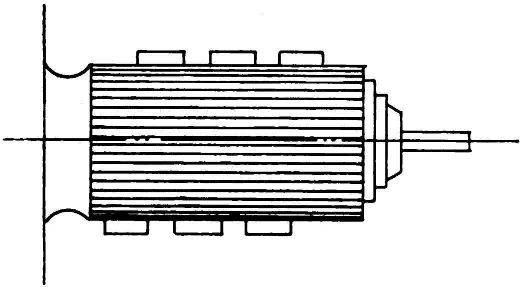


Fig. 20. How Motor and Dynamo Brushes should be Set.

are so set on a new machine (or one that has had commutator turned) that they overlap. Figs. 19 and 20 show how they should and should not be set. If grooving of the commutator has occurred, the end play on the armature shaft causes the sides of the grooves to press on the sides of the brushes, intermittently causing them to take an incline. This results in great pressure on one side, and a gap on the other, as shown in Fig. 20.

It may be that sparking is caused by running motor at too fast a speed. Should this not be covered by the points enumerated below and motor is fitted with a regulator, the fault lies in the latter. Regulators should be carefully considered, and on no account whatever should the shunt current be so weakened as to allow the motor to run beyond the speed given by the makers. The result of doing so is to nullify the magnetic field by the armature.

It would always be as well when dealing with motors to study carefully the question of vibration. It is a general practice in workshops to get the motor up overhead and so save valuable floor space. This is usually done by bolting to iron brackets, and in many cases this is the cause of vibration and consequent heavy sparking. It must be checked, and very careful staying is necessary. When examining a motor and its supports for above, run motor up under normal conditions. It is quite useless to try and locate vibration with a motor running on, say, no load. The speed of any motor shows some variation when loaded and while running at, say, 1250 revolutions per minute, vibration may be absent, yet at 1200 revolutions per minute it may be quite pronounced. This is best illustrated by a piano. A particular note being struck, some ornament, perhaps, in the room vibrates in unison with it. So with our motor. Certain vibrations will be reciprocated by the brackets. It should be stopped at once. For a temporary measure increase the tension on brushes, but on no account leave it at this.

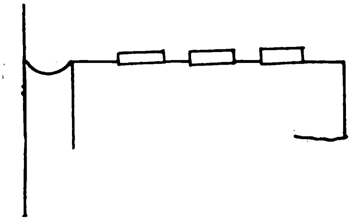


Fig. 21. An Example of Bad Grooving of the Commutator from badly-set Brushes.

(*To be continued.*)

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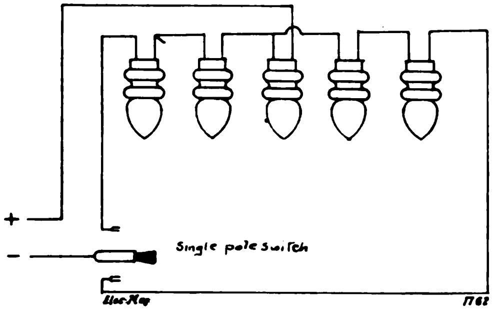
Notes.

Herewith we give the best answer to our problem in the January number. This was to light three arcs in series, using the centre lamp in each case. The method shown is



Correct Solution of Arc Lamp Problem.

the simplest, and has been received from many sources, the best being from A. E. Mitchell, Cheshunt, Herts.

An Opportunity.

Foremen and others wishing to augment their income without in any way interfering with present employment would do well to write for particulars to "Amsoc," c/o The Electrical Magazine, 4, Southampton Row, London, W.C.

N.B.—No fees of any kind.

The World's ELECTRICAL LITERATURE

Power.

Articles.

Los Angeles Plant of Edison Co.	*Power, Feb./06.*
*Design, Construction, and Application of Large Gas Engines in Europe. F. E. Junge.	*Power, Feb./06.*
Producer Gas and Gas Producers. C. H. Day.	*Power, Feb./06.*
Architecture of Continental Power Stations. F. Koester.	*Elec. Wld. & Engr.* 3/1/06.
The London Power Situation. T. H. Minshall.	*Elec. Wld. & Engr.* 13/1/06.
Hydro-Electric Plant of Sofia, Bulgaria. F. Koester.	*Elec. Wld. & Engr.* 27/1/06.
Electric Motors for Driving Induced Draught Fans.	*Elec. Rev.*, 9/2/06.
Electric Power Distribution in North Wales.	*Electrn.*, 26/1/06.

Papers.

Gas Engines Applied to Electric Driving J. Atkinson.	*Manch. I. E.E.* 26/1/06.

Traction.

Articles.

Orleans Electric Road in Suburbs of Paris. C. L. Durand.	*Elec. Rev.*, N.Y. 3/2/06.
*Use of Alternating Current for Heavy Railway Service. B. G. Lamme.	*Strt. Rly. Journal.* 6/1/01.
Construction of Modern Amusement Parks.	*Strt. Rly. Journal.* 13/1/06.
Canadian System of Collecting Fares.	*Strt. Rly. Journal.* 27/1/06.
Repair Shop Practice on Montreal Street Railway.	*Strt. Rly. Journal.* 27/1/06.
*Electrification of Trunk Line Railways. H. Ward Leonard.	*Strt. Rly. Journal.* 27/1/06.
Single-Phase Railway in Paris. P. Letheule.	*Strt. Rly. Journal.* 10/2/06.
Repair Shop Practices of The Toronto Railway.	*Strt. Rly. Journal.* 10/2/06.
Overhead Construction. A. Lineman.	*Elec. Rev.*, 2/2/06.
Kingsway Shallow Tunnel Tramway.	*Electrn.*, 2/2/06.
Baker Street and Waterloo Railway.	*Electrn.*, 16/2/06.
Electric Ignition for Motor Cars. F. Little.	*Electrn.*, 16/2/06.

Central Station Practice.

Articles.

Taking Care of an Engine. W. H. Wakeman.	*Power, Feb. /06.*
*Why the Steam Turbine is not more Efficient. R. M. Neilson.	*Power, Feb./06.*
Steam Boiler Efficiencies. J. B. C. Kershaw.	*Power, Feb./06.*
Central Stations *v.* Isolated Plants. A. Yost.	*Power, Feb./06.*
Newspaper Advertising for Central Stations. F. B. Rae.	*Elec. Wld.*, 3/1/06.
Reducing Fire Hazards on a Motor Circuit. D. J. Burns.	*Elec. Wld.*, 3/2/06.
Advertising Follow-up Methods for Central Stations. F. B. Rae.	*Elec. Wld.*, 3/2/06.
Electricity Meters C. H. W. Gerhardi.	*Electrn.*, 26/2/06.

Papers.

Increasing the Power Output of Central Stations. P. H. Korst.	*Nor. West. Elec Assoc.*, 17/1/06.
*Power Plant Economics. H. G. Stott. (*See* Central Station this Month)	*Amer. I.E.E.* 27/1/06.
Maintenance of Underground Mains. G. L. Black.	*Glasgow I.E.E.* 13/2/06.
Idle Currents. M. B. Field	*Manch. I.E.E.* 13/2/06.

Lighting and Heating.

Articles.

The Lighting of Living Rooms and Parlours. J. R. Cravath and V. R. Lansingh.	*Elec. Wld.*, 3/1/06.
Obstacles in the way of Electric Heating. C. D. Wood.	*Elec. Wld.*, 3/2/06.
Lighting of Dining and Bedrooms. J. R. Cravath and V. R. Lansingh.	*Elec. Wld.*, 3/2/06.

Papers.

Progress in Electric Lighting. L. Gaster.	*Soc. Arts*, 7/2/06.

Telegraphy and Telephony.

Articles.

Review of Wireless Telegraphy. W. Mayer.	*Elec. Rev.*, N.Y. 20/1/06.
Telephone Patents Issued During 1905. E. E. Clement.	*Elec. Rev.*, N.Y. 20/1/06.
London Glasgow Underground Telegraph System.	*Elec. Rev.*, 26/1/06.
City Exchange Post Office Telephone System.	*Elec. Rev.*, 26/1/06.
Wave Lengths in Wireless Telegraphy. H. J. Round.	*Electrn.*, 16/2/06.

Electro-Physics.

Articles.

Electrical Nature of Matter and Radioactivity. H. C. Jones. (*See* Electro-Physics this month.)	*Elec. Rev.*, N.Y 20/1/06.

Electro-Chemistry.

Articles.

Electro-Chemical and Metallurgical Progress in 1905. F. S. Spiers.	*Elec. Rev.*, 16/2/06.

Papers.

Electric Production of Nitrates from the Atmosphere. S. P. Thompson.	*Royal Inst.*, 2/2/06.

Electrical Design and Manufacture.

Articles.

Auxiliary Reversing Poles for large C. C. Dynamos. H. M. Hobart. (*See* Design this month)	*Elec. Rev.*, N.Y. 20/1/06.
Contribution to the Theory of the Single-Phase Induction Motor. V. A. Fynn.	*Elec. Rev.*, 9/2/06.
Series Transformers for Wattmeters. L. W. Wild.	*Electrn.*, 16/2/06.

Papers.

A Self-Exciting Alternator. E. F. Alexanderson.	*Amer. I.E.E.* 27/1/06.
*High-Speed Electric Machinery. S. P. Thompson.	*Soc. Arts*, 1/2/06
Recent Electrical Measuring Instruments. K. Edgcumbe.	*Junr. Inst. Eng.* 2/2/06.
Crane Motors and Crane Controllers. C. W. Hill.	*Inst. E.E.*, 22/2/06.

Wiremen.

Articles.

Exposed Circuit Wiring. L. J. Auerbacher.	*Elec. Wld. & Eng.* 3/1/06.
Wiring with Wooden Mouldings L. J. Auerbacher.	*Elec. Wld. & Engr.* 3/2/06

Papers.

Conduits. L. M. Waterhouse.	*Elec. Contract. Assoc*, 20/2/06

MANUFACTURING Progress

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Progress in Controller Design.

THE types of controllers at one time used for motors of all classes were crudeness itself in design, and the embodiment of imperfection in manufacture. Motor design and manufacture, indeed, threatened to outrun the development of efficient starting devices, and, paradoxically, the need of good controlling gear held back the advance of the electromotor at a period when it most required a boom. Radical changes have, however, altered these incongruities, and to-day the maker of starting and controlling apparatus has quite made up lost ground.

The Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham, write us regarding their progress in this field during the past year, and we understand they have made several important changes in their main range of products. Foremost among their standard apparatus we may place controllers for cranes and variable speed motors. In developing these they proceeded with some caution to ensure that proper attention was paid to design, both from the electrical and mechanical standpoints. Before coming into the market the most stringent tests were carried out to give an unquestionably reliable article. The soundness of this policy is fully testified to by the large numbers of controllers sold, and by the placing of yearly contracts for them by some of the best crane makers in the United Kingdom.

We are informed that standard controllers are offered to meet any requirement or conditions likely to arise in practice with cranes, machine tools, &c. No wood, fibre, or combustible material is used, and no effort is spared to make the apparatus absolutely fireproof. Arcing from contact to contact is impossible, as each finger and contact is enclosed in a fireproof chamber, and the bar carrying the contact holders is covered with insulating material throughout its entire length. The blow-out arms can be swung back to admit of access to the contacts, and all other parts are equally easy of examina-

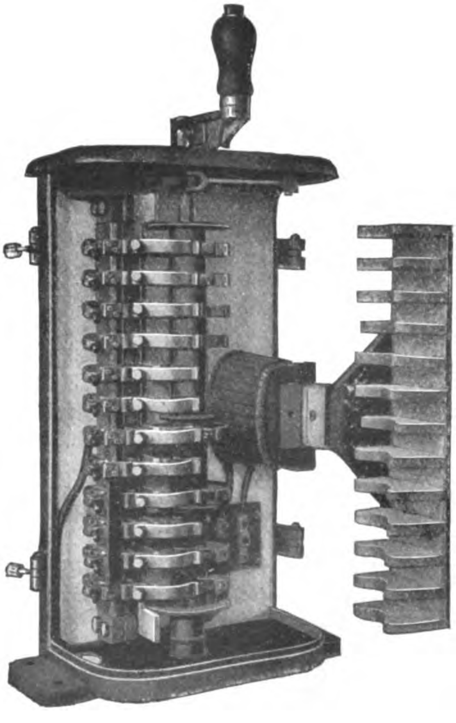


FIG. 1. STANDARD DRUM-TYPE CRANE CONTROLLER OF ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD.

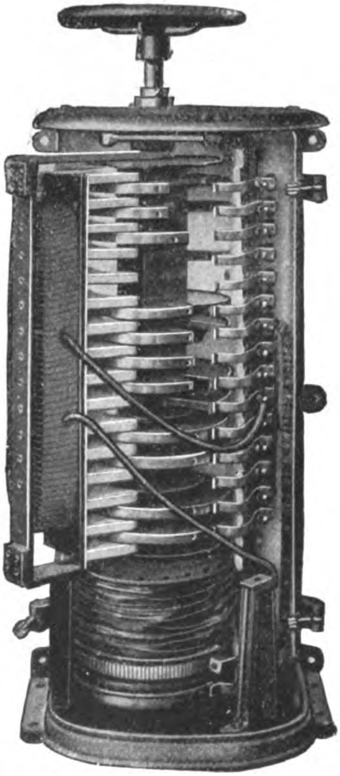


FIG. 2. DRUM-TYPE CONTROLLER FOR VARIABLE SPEED MOTORS, MADE BY ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD.

tion. Reference to Fig. 1, which shows a standard drum-type crane controller opened out, will make it abundantly clear that everything is readily free of inspection.

The controller illustrated in Fig. 2 is suitable for machine tool work, and has been supplied largely for the three-wire system for 220 and 440 volts. With this pattern of controller forty different speeds can be obtained with shunt regulation, and ten additional speeds with armature regulation, making fifty in all, with one barrel or drum and one handle.

The Stellite magnetic starter to which we referred briefly in a previous issue is now being standardized, and will shortly be ready for prompt delivery in all sizes. This starter, which is illustrated in Fig. 3, possesses the valuable feature of absolutely ensuring the slow starting of the motor independently of the action of the operator. The starter may well be termed fool proof, and is to be recommended where there is the likelihood of careless handling. Its action is as follows: The loose arm carries a pot magnet, and in starting is pushed towards the switch arm from left to right. When nearing the latter a contact is passed which energises the magnet, and loose arm and switch arm are securely held together by a magnetic pull dependent on the strength of the line current. Both arms can now be moved over, and the motor starts up gradually; but if any attempt is made to hurry the process, an excess current de-energises the magnet holding the arms together and causes the return of the switch arm to the off position These starters are supplied up to 50h.p. for pressures up to 500 volts.

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Motor Starting Panels, &c.

POWER supply in bulk has occasioned many modifications in the design of electrical apparatus, while it is also responsible for creations of its own. Prominent among these may be mentioned the heavy motor starting panel and fuse now essential to the installation of electric power on a large scale. Past experience has demonstrated that the manufacture of devices of this kind is only thoroughly done justice to when it is in the hands of specialists who undertake nothing else. This is particularly noticeable with the products of A.

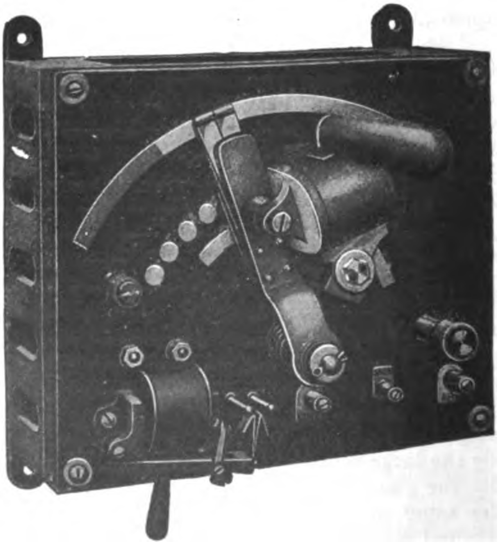

FIG. 3. STELLITE GRADUAL MOTOR STARTER IN THE "ON" POSITION.

Reyrolle and Co., Ltd, Hebburn-on-Tyne, who have devoted their energies to the production of satisfactory motor starting apparatus and panels equipped in a compact manner with these devices. In our Olympia Souvenir issue we described some of the ironclad motor starting units made by the Company, and we are now in a position to give some illustrated particulars of its fuses and starting panels. The construction of these tubular fuses is shown upon Fig. 1, and while they follow certain well-known lines they possess one feature peculiar to themselves. This is that, as shown in the section, they contain two thick asbestos tubes marked respectively *a* and *d* inside the handle. The innermost tube is most effective in extinguishing the arc caused by the fuse blowing. The external tube and the ventilated air duct between the two tubes serve to keep the handle cool and so reduces to a minimum the risk of breakages and discomfort to the operator The operation of re-making a fuse is simple in the extreme and very inexpensive, as it only means clamping a new copper wire under some set screws. Tests made upon dead shorts with this type of fuse by independent authorities have proved its efficiency and warranted its extensive use.

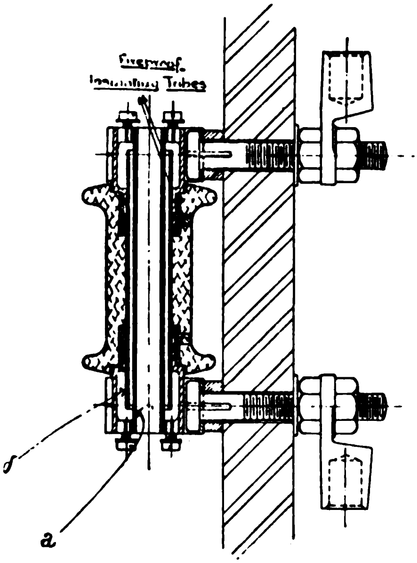

Fig. 1. Reyrolle Heavy Current Fuse for Medium Voltages.

Fig. 2 illustrates a panel fitted with these fuses, and it will be noticed that the pre-

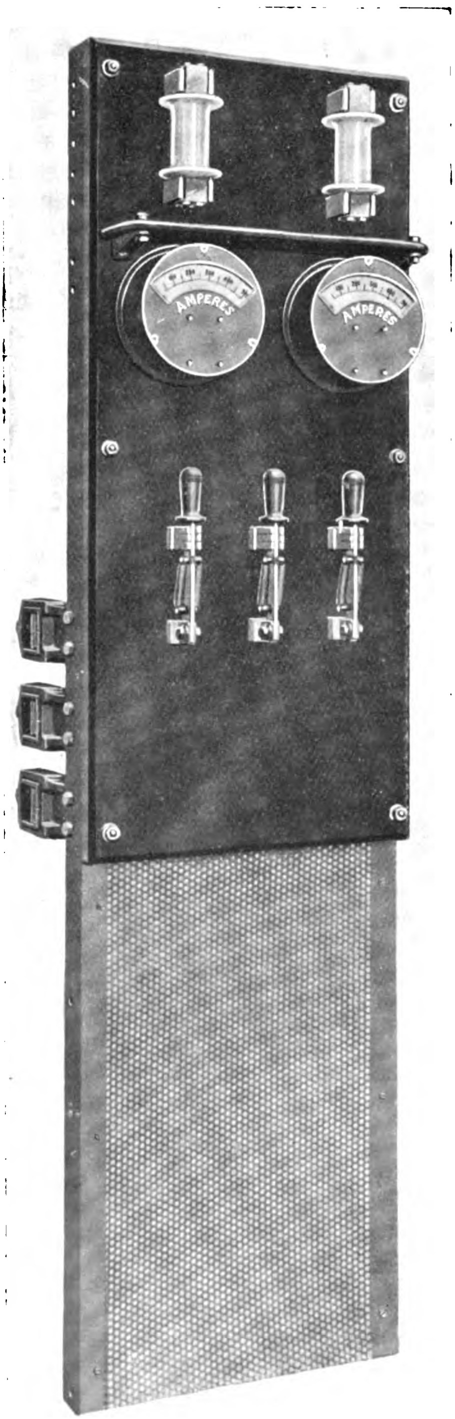

Fig. 2. Reyrolle Standard Three-wire Feeder Panel.

caution is taken of mounting them at the top of the board and separating them from the instruments below by a slate division. It is not an uncommon thing for fuses placed in the body of a board, among instruments and switches, to burst and cause destructive arcing between its contacts and surrounding live metal. Fig. 3 depicts a neat wall type of three-phase H.T. controlling panel, with oil break switch, potential indicator ammeter, and overload relay The mounting of the fittings on the slate base which is supported on the angle iron-work makes up a very neat panel, and one which should reduce the possibility of accidents to a minimum. Needless to say the design is practically fireproof.

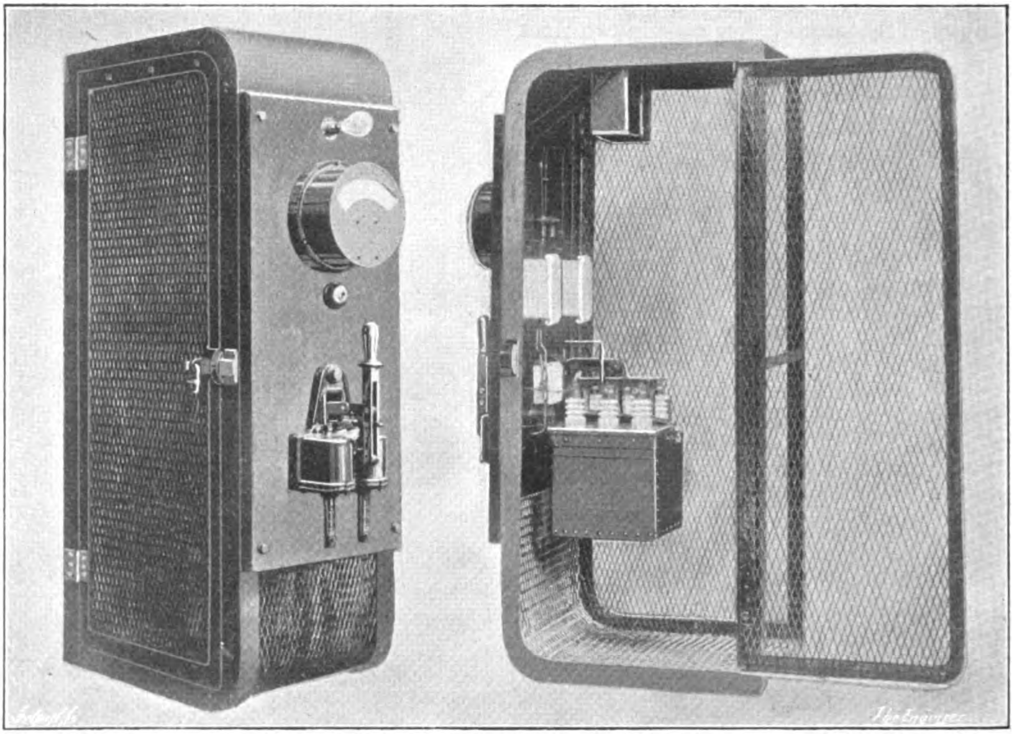

FIG. 3. REYROLLE HIGH VOLTAGE THREE-PHASE SWITCHING PANEL.

To go through all the interesting articles produced at the Hebburn Works would occupy more space than is at our disposal, but we may mention that these include distributing boxes for works, shipyards, &c.; house service boxes and ironclad distribution boards for house and workshop wiring.

The H. T. switch department is kept constantly busy. One of their well-known accessories in this section is very valuable. This is the standard three core cable dividing box as used upon all H. T. switchboards upon the Newcastle-upon-Tyne Electric Supply Company's system. It enables H. T. leads from a three-core cable to be readily and safely brought out to individual terminals, an essential in all cases of high-voltage service.

A visit to the works of this enterprising firm would repay any engineer, especially if he be interested in good organization and accuracy, not only in regard to the manufacture of mechanical devices, but also in the control of manufacturing costs, &c. The company, whose works were originally in London, moved, at the instigation of the Newcastle-upon-Tyne Electric Supply Co., Ltd., to its present field in 1902, and the success of the supply company and their freedom from switchboard troubles is in no small measure due to the excellent work produced for them in Messrs. Reyrolle's extensive shops.

Romapac Compound Tram Rails.

There can be no co-operation among inventors, otherwise just the right things would be invented at just the right time, and those subsequently put in charge of the apparatus in question would be spared endless trouble. Why, for instance, when tramways, and especially electric tramways, were introduced, was not provision made to renew the working section of the rail without disturbing the base section? By what rule of progressive effort must this indispensable feature of such a system assume practical shape only after years of tramway operation, involving the endless uprooting of old rails and scrapping of valuable lengths of otherwise good material? Whatever the answer be, the fact remains that now the importance of the compound rail is greatly emphasized by the existence of a method which makes it a practical and efficient possibility; further, the simplicity of the means adopted at once commends the system to the tramway fraternity at large.

On February 9th we attended a gathering in Leeds of technical pressmen to witness a demonstration of Romapac rolling, bending, and cutting machinery for applying or removing an upper renewable section to a lower permanent girder tramway rail. The special apparatus employed, which is the subject of the company's patents, and is in fact the feature of their system, comprises a portable steam rolling, bending, and cutting machine, carried by a truck which runs on the standard gauge of tram rails. A powerful steam engine drives the different motions through gearing, and also propels the machine over the track. The first essential is the replacement of the old girder rail by one of special T section, and this, when laid, remains permanently embedded in the road. This base section forms 59 per cent. of the whole rail, and the wearing portion, the other 41 per cent., is rolled on to it by a cold welding process. The machine is run over the track with the loose head in position, and lateral pressure is applied to the depending edges, which are gradually forced into contact with the girder head of the T rail. The rolling machine and a section of top rail in position are shown in Figs. 1 and 2. This formed the first part of the demonstration, and occupied about ten minutes on an 80ft. length of rail. No detail of the practical application of the machine has been overlooked, and provision is made and was next demonstrated for removing the rail from position when worn. A simple cutting away of one of the tongues had been tried, but it had been found necessary to adopt a cutting

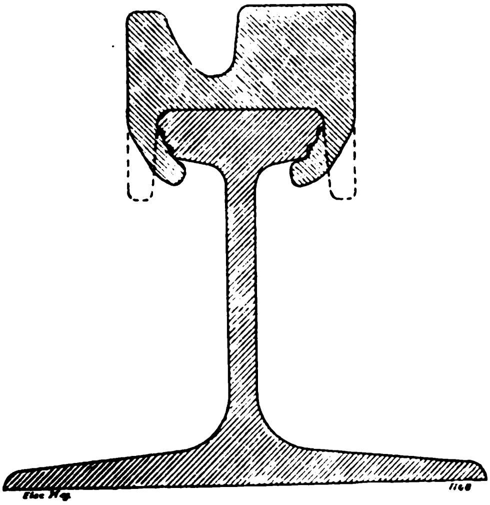

Fig. 1. Section through Romapac Compound Tram Rail.

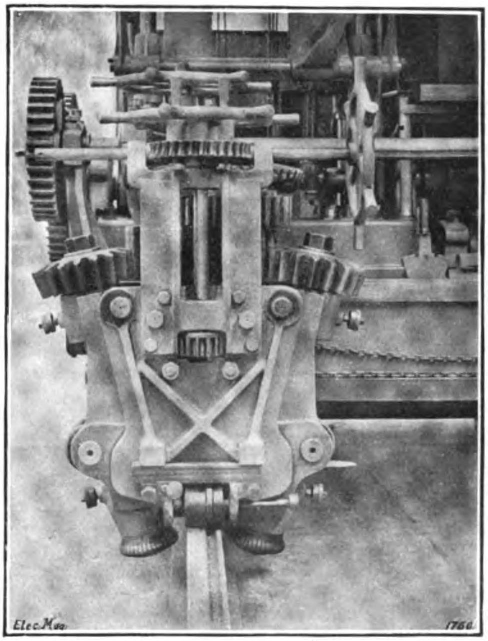

Fig. 2. Rolling Attachment for Romapac Machine.

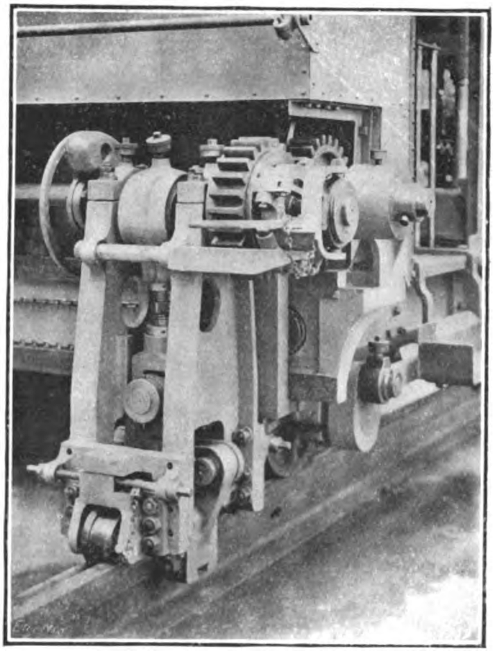

Fig. 3. Special Bending and Breaking-off Attachment of Romapac Machine.

and breaking process to remove the pressure and clear the rail. A circular cutter is fixed in place of one of the rollers of the first process, and after a deep cut is made, the partly severed tongue is completely broken off by a special attachment to the travelling truck shown in Fig 3. This very successfully showed its power in snapping off the tongue and leaving the rail head free to be prised off with very little upward pressure. There was not the slightest hitch in the proceedings, and the capabilities of the machine were fully exemplified in the various tests.

The system does not admit of application to existing sections of tram rails, as no provision is made for cutting off or in any way shaping the head of the old rail base. In refusing to compromise with the old rail we think the inventor has done the correct thing. His proposals are accordingly more definite, and, in view of the material saving on renewals—this is put at 53 per cent.—the system is more likely to find acceptance than any tinkering with existing rails. The cost of laying is slightly higher than the simple rail, but is quite overbalanced by the saving when renewals are made. The eplacement of a worn rail, for instance, involves the removal of a few sets only from each side of the rails and not their entire disturbance between metals and some distance each side. We understand that no trouble is anticipated with electrical resistance between girder rail and head, nor with any tendency to creep by the upper rail.

There seems to be a future before the system, and the engineer and inventor, Mr. Rhodes, is to be congratulated on satisfactorily solving a problem which has baffled all previous attempts at solution. We shall await the verdict of the tramway industry on his efforts with considerable interest, as it certainly seems as if here, at least, is a means of increasing the life of a tramway track in busy thoroughfares; at any rate it will reduce the cost of operation and maintenance to an appreciable degree.

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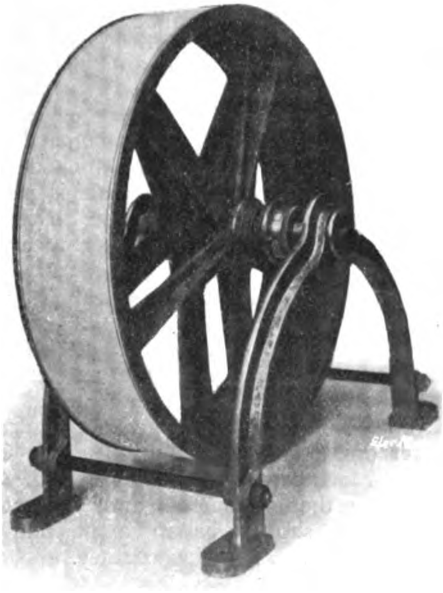
Calculating Apparatus.

MATHEMATICS may be delightful for its own sake, but tedious and monotonous calculations should always be reduced to mechanics. We possess the necessary skill to give highly accurate results by these means, and it were foolish to deprecate the general employment of them in commercial work, where time is always at a high value. Messrs. John Davis & Son (Derby), Ltd., have constantly contributed to present knowledge of time-saving calculating devices, and in fact may be said to have directed the design and manufacture of such apparatus for many years past. They have now put on the market a piecework balance and premium calculator, whereby much annoyance and delay in the casting-up of workmen's wages at piecework and premium rates can be entirely obviated. The apparatus is simplicity itself, and comprises a pair of circular scales laid on the periphery of two drums, mounted on a common spindle, but capable of independent motion in either direction.

The instrument is provided with scales, approximately 11ft. long, having a range from 1d. to £20, and marked so that they can be used either for money or time calculations. Small sections of these scales, approximately half-size, are illustrated herewith. Divisions of the scale are from pennies from the lowest amount up to £1. From £1 to £3 the divisions are in 2d. Balances



Smith-Davis Premium Calculator for Works and Business Establishments.

within these ranges can be read with ease to one halfpenny. From £3 to £10 each division represents 6d. From £10 to £20 each division represents shillings, and in the latter range 6d. can be easily read.

When the desired relative position of the two scales has been obtained, a treadle is released, and the two wheels are automatically locked firmly together.

For piece-work it is convenient to use the left-hand scale as the wages scale and the right-hand scale as the balance scale. The purpose and method of using the instrument can be readily shown by an example.

Five men, L, M, N, O, and P, whose combined weekly wages amount to £12 15s., are engaged on a contract worth £17 12s. 6d.; the difference of these two amounts, viz., £4 17s. 6d., is the balance which has to be divided amongst the men in amounts proportionate to their fixed wage. To find the proportion of the balance due to each man, £4 17s. 6d. on the balance scale is placed opposite to £12 15s. on the wages scale. Then on the balance scale opposite the amount of each man's weekly wage on the wages scale will be found the proportion of the balance to which he is entitled.

For premium work it is only necessary to use a short range of the scales, and where the premium system is extensively used, although the instrument above referred to will serve every purpose, it is handier to use a smaller instrument with special scales, such as is illustrated herewith.

This instrument is a time and labour-saving device, to be used for quickly finding, without performing the usual sums in proportion, the time allowance that has to be added to the actual time occupied, when the latter is less than the agreed contract time. The instrument is provided with scales, aproximately 4ft. 6in. long, divided and figured so that readings can easily be made either in units of time or money; the range being from 5 minutes to 60 hours in time, and from 1d. to 60 shillings in money. This composite dividing and figuring is most generally useful, but when specially desired the scales can be figured for time calculations only. The usefulness of the scale is not limited by its range; for dealing with amounts of money or time beyond 60 shillings or 60 hours, it is only necessary to divide greater amounts by a common divisor to bring them down to a figure within the 60 hours or 60 shillings, the range of the scale being amply sufficient for all final readings. If, however, many of the final readings should be beyond the range of the scales, it would be better to use a piece-work balance calculator, the scales of which give a range from zero up to 400 hours or 400 shillings.

The scales, which are engine divided on strips of celluloid to ensure accuracy, are affixed to the rims of two similar metal wheels about 17in. in diameter, and so arranged that the divided edges come together. The wheels are mounted on a spindle which is carried at each end in bearings formed in a supporting stand. One wheel is fixed to the spindle while the other is free to revolve upon it. The free wheel is pressed against the fixed wheel by a spring which is sufficiently strong to cause it to turn with the fixed wheel when the latter is rotated. The amount of friction between the two wheels can be adjusted to suit the operator by a simple nut arrangement.

Messrs. Davis also manufacture a line of speedometers for stationary engines and motor cars, and a special double-slide rule by which a spare slide containing a logologarithmic scale can be temporarily attached to the body of the rule and used in conjunction with a special cursor with any scale on the ordinary slide.

Frequency Indicators.

EXPERIENCE has demonstrated that the simplest form of instrument can be employed to measure the frequency of any alternate-current circuit. No compensated moving coil instruments, and in fact no specially electrical device, are required, because the phenomena of resonance when reduced to practical mechanics answer the purpose admirably, and at once provide a perfectly simple instrument. The method adopted by Hermann Frahm in his frequency and speed indicating devices, is based on the response which elastic bodies make to rhythmic impulses when their particular frequency corresponds with that of the body imparting the impulses. A specially prepared steel spring is found to be the most suitable responding medium, and in the instrument in question a series of these, after tuning to the desired scale, are mounted on a bar which in turn is fixed to two bridges screwed to a supporting pillar as shown in Fig. 1. Mounted in this manner the comb of springs is best fitted to receive external impulses, and the responding spring is free to vibrate. In ascertaining the frequency of an a.c. circuit, the comb is fixed as before and the armature of an electromagnet in the secondary circuit is placed in contact with the comb, as shown in Fig. 2, which depicts the complete instrument. A scale is placed parallel with the springs, and the amplitude of vibration is such that the appearance of a solid line is given to the vibrating head which approaches the scale at each side and permits of the reading being taken. Nothing simpler than this could well be imagined, and now that the instrument is on the market at a comparatively low price, a.c. engineers will have no excuse for the absence of a frequency meter on their systems. W. Lucy & Co., Ltd., Electrical Engineers, Oxford, are supplying the instruments and, we understand, will shortly be in a position to manufacture them in this country.

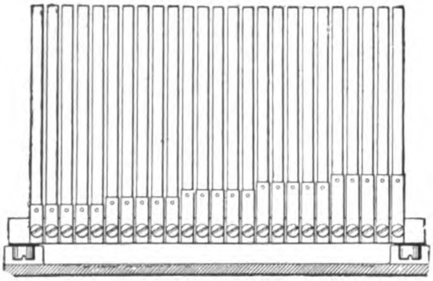


FIG. 1. COMB AND BRIDGE OF FRAHM FREQUENCY AND SPEED INDICATOR.

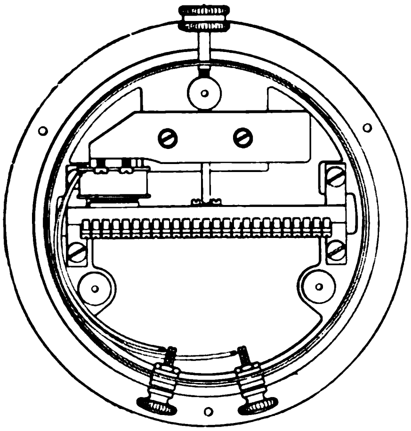


FIG. 2. COMPLETE FRAHM SPEED INDICATOR, SHOWING MAGNET AND VIBRATING COMB.

New Catalogues.

A Correction.—On page 75 of the last issue our rendering of the name R. Cundall & Sons, Ltd., should have read Cundall, Sons & Co., Ltd., the designation of the reconstructed firm.

Electric Accessories and Fittings.—W. MCGEOCH & CO., LTD., Glasgow, Birmingham, and London. A very handsome publication is just to hand from McGeoch and Co., which goes very fully into details of the company's many specialities in electric light accessories and fittings. It is divided into eleven sections, each representing a distinct department of the concern. To describe these closely would fill a small volume, but some idea of the field covered is conveyed by the fact that the catalogue, which is 9 by 11, contains upwards of 500 pages of illustrated matter. In the fittings department many beautiful designs are stocked, and the most exacting taste can be met from a selection which is as wide as it is varied. Every electrical contractor should be in possession of a copy, and we understand one will be forwarded on receipt of trade card.

Bennis Publications.—We have received from the publication department of Ed. Bennis & Co., Ltd., 28, Victoria Street, Westminster, two useful pamphlets dealing with mechanical stoking and coal-handling plant at Coventry Electricity Works and a number of London stations. Bennis plant is used in each case, and the economies introduced thereby are pointed out in the reading matter.

The Electrical Magazine.

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THEO. FEILDEN.

Acting Editor:
W. E. WARRILOW, A.M.I.E.E.

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The World's Electric Progress.

Gathering of Foreign Engineers.

THE Institution of Electrical Engineers has arranged what will prove to be a most important *réunion* of electrical engineers for the coming summer. A cordial invitation to visit this country has been accepted by the chief electrical associations of Canada, France, Germany, Italy, Switzerland, and the United States, and the members of each society electing to take the trip are timed to reach London on June 23rd and 24th next. The meeting should be a highly successful one considering the extent and character of the programme arranged for the delectation of the visitors. It includes four days in London, and a provincial tour including Birmingham, Manchester, Liverpool, the Lake District (for a week end), Glasgow, Edinburgh, Newcastle, and Leeds, and between start and return the best that the country can show in the way of engineering and electrical works will be inspected. The Institution is to be congratulated on the representative character of the route selected, and we are sure its efforts will be well supported by British electrical engineers in extending the heartiest possible welcome to our distinguished friends from abroad.

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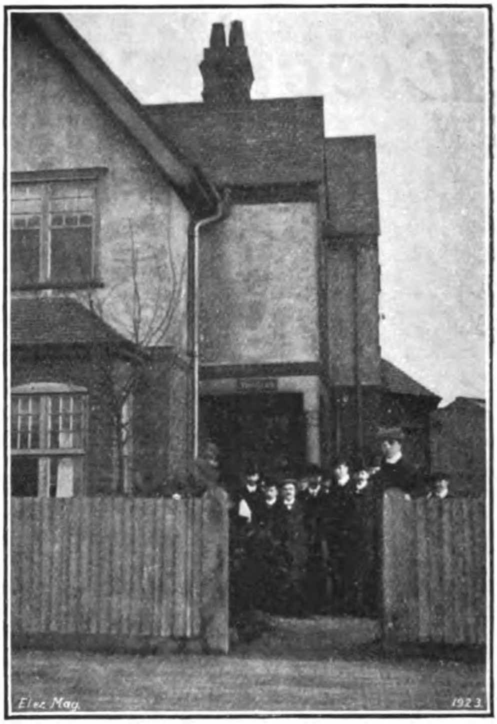
"Seeing Things" by 'Phone.

WE are taught to hope for an instrument which will make telephone conversations infinitely more pleasurable because both parties will see each other. The following from a telephonic contemporary, however, anticipates matters somewhat, and is a story told of a telephone pay station: "It is well understood that by simply dropping in the proper coins these stations will notify central of the amount deposited without requiring the user to work buttons or levers. It has lately been found that they show central the different coins received, and while the latter feature has not been patented by the Gray Company it is fully claimed by two gentlemen who have had this feature demonstrated to them. It came about in this way: they went into a public pay station booth at the depot, and after Mr. B—— took down the receiver and gave the operator the number required, he turned to his friend with the following question. 'Say, Jack, this ought to be a good place to get rid of a plugged nickel, oughtn't it?' 'Sure,' was the reply, whereupon central was heard to say: 'Drop in five cents, please.' The plugged nickel was dropped with a smile. A momentary pause, and central again repeated sweetly, 'Drop in five cents, please.' 'I have dropped it,' replied Mr. B——. 'I know, but that one was plugged; now drop in a good one,' replied central. A good nickel was quickly deposited in the slot and the desired party had. Now the gentlemen are willing to swear that the Gray pay station shows central all that occurs inside of public booths, and while they will not tell just how it happened, they are positive it shows central the coins. Had they discussed the plugged coin matter before taking down the receiver, it would have saved them not only the worry of how it is possible to see by telephone, but also the trouble they now have of carefully adjusting their neckties before they can be induced to enter a public pay station booth where there is a Gray device."

British Carbons. It is high time that steps were taken to ensure that the only British Carbon Works should receive the home support which their very existence merits, and which a period of six years' operation fully justifies. When one thinks seriously about it, the supply of our demand in these islands for arc lamp carbons is a national affair, one in which the Government should be keenly interested. Are not its naval and military forces dependent upon this commodity, and should it not see that a home manufacture is cultivated and encouraged to meet its demands at all times, but, especially on the outbreak of hostilities? Until the General Electric Co., Ltd., erected its Witton carbon works and proved to British electrical engineers that its products were superior to foreign-made goods, none but imported carbons were used in this country. For six years British-made carbons have made their appeal to that patriotism of which Englishmen are said to be proud —with what result? Of the 30 million feet annually consumed, 10 million only are taken from the home maker. The whole difficulty turns on the price. Foreign competitors keep up and put up the selling price at home and reduce their figures here to compete with and quash the home manufacturer. In a recent visit of press representatives, which we were privileged to attend, to the Witton Works, we were informed that unless the municipalities of this country give their carbon contracts at home, and unless the Government takes some steps to secure the home market for the home maker, the company would have to reconsider the utility of its experiment and hard fight against adverse circumstances. If the obviously unfair competition were persisted in, nothing would remain but to close down the factory and turn away the three hundred hands whom years of patience and expense have trained to proficiency. We do hope that the very strong appeal which the company is making through the Press and other channels to secure at least justice for its undertaking, will meet with a response from all quarters, and influence the retaining in our midst of an industry the national value of which cannot for a moment be disputed. Little or no effort would be needed to divert the present flow of British orders from the foreign market.



"THE CLUB" ATTACHED TO THE WITTON WORKS OF THE GENERAL ELECTRIC CO., LTD.

GROUP OF JOURNALISTS AT THE CARBON WORKS OF THE GENERAL ELECTRIC CO., LTD., WITTON, BIRMINGHAM.

The Telephone War.

WE have repeatedly referred in these columns to the fierce character of the telephone war in the United States between the Bell and Independent interests. Both parties have their own Press journals and the editorial comments of each side make very good reading when there is a hot subject down for discussion. Our contemporary, Telephony, recently published an article by Henry Laws Webb attacking the municipal telephone movement in this country, and as it is an Independent journal it was promptly taken to task by an Independent contemporary, Sound Waves, who strongly resented the insertion of matter prejudicial to Independent interests written by a "myrmidon" of the Bell monopoly. In an editorial note it says:—"We cannot understand why, with such ample opportunities to secure an impartial review of the British telephone situation, our contemporary should have lent its columns to a prejudiced observer. By so doing it has incurred just criticism and laid itself wide open to the serious charge of being a "Bell" advocate. It must remember that those who consort with Bell men incur the suspicion of Bell contamination. 'He who sups with the devil must use a long spoon.' They seek to have us infer that their attack on municipal telephony is for the sake of warning the country against the pitfalls of municipal ownership, and that they are 'agin' something that may overthrow both Independent and Bell interests, while in the next breath they disclaim responsibility for Mr. Webb's article, thus accomplishing a straddle of the issue. We don't know what leg they will elect to stand on finally. If municipal telephony is coming, however, even the mighty blasts from our contemporary's horn won't stop it. We don't advocate it, but there is something worse—Bell monopoly. It one is purgatory the other would be hell. With municipalism in the saddle there would still be extension and progress. Independent manufacturers would still find a market for their goods and able engineers would still be in demand. We do not propose to discuss the relative merits of telephone equipment and practice in Europe and the United States, for no possible good could come therefrom. We know, however, that if it suited to Mr. Webb's purpose he could quite as consistently ridicule the class of equipment in Stockholm, Sweden, or Berlin." Unfortunately there is no organ of municipal telephony in this country, or we might be in a position to quote more than pointed references of each party to the other. Let us hope, however, that the future State control of our telephone service will be conducive to greater speed and promptitude than now prevails under the auspices of monopoly, which has had its way long enough.

A THREATENED BRITISH INDUSTRY—THE WITTON CARBON WORKS OF THE GENERAL ELECTRIC CO., LTD.

With Siemens at Stafford.

The marked extent to which manufacturers are conserving British electrical interests was recently demonstrated to a party of journalists which visited the Stafford works of Siemens Bros. & Co., Ltd. The *raison d'être* of the trip was the inspection of two 1350kw. two-phase generators which were on the test plate at the works and were to be shipped to South Africa for the Johannesburg Corporation. The demonstration of this test was a matter of great interest and was closely followed, the machines fulfilling in every way the anticipations of the designers. The Hopkinson test was employed, in which both alternators were coupled together and to a 66 h.p. d.c. motor which supplied power to overcome the losses of the two machines. From the input readings of this machine the total losses of one alternator without bearing friction worked out at 83kw. at an output of 1800K.V.A., this result giving an efficiency of 94.3 per cent. at cos = 1. A low temperature rise was called for by the specification, and the machines were accordingly rated somewhat lower than the firm's standard practice. Had this latter been adopted, allowing a temperature rise of 70° F., the same size of machine would have delivered 2400K.V.A. Our illustrations depict the stator of one machine and the two sets together on bed plate with testing instruments. After inspecting these machines Mr. C. F. von Siemens conducted us over the works, and some highly interesting work under construction was examined. Turbo-generators and interpole dynamos and motors were among the chief specialities, the former particularly presenting many novel points in the matter of ventilation. Air ducts are provided directly below the stator slots in a.c. machines and through the commutator segments in d.c. generators, a vigorous circulation being set up by fan-shaped end pieces on the rotating member in each case, these pieces also acting as shields to the windings, preventing them spreading by centrifugal force. The system of ventilation has been well thought out and its practical application is one of the neatest things we have seen in construction work. In the space of this short note we cannot detail all we saw during our tour of the shops—a description of this we must leave till later—but we were certainly much impressed with the enterprise of the firm in bringing their plant up to date and in keeping pace with the times in matters of design and manufacture.

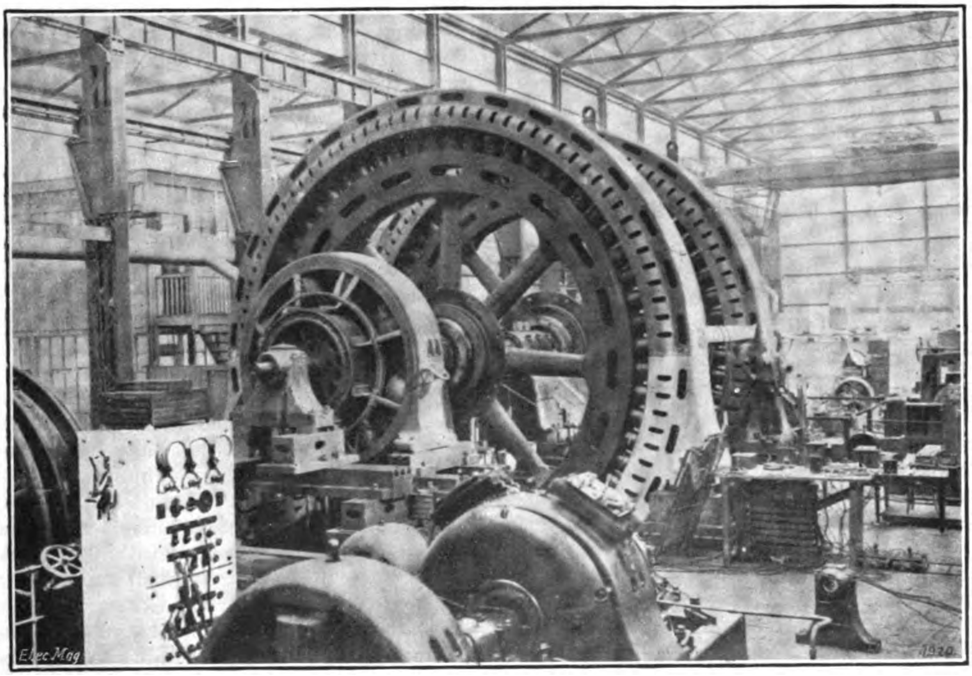
* * *

Illuminating Engineering.

THE spread of electric lighting has given rise to a situation which calls for the protection of the would-be consumer of that commodity from the imposition of ignorant and often fraudulent advisers. The wiring of any building requiring more than 100 lighting positions or points is a matter which should be in the hands of more than the ordinary wiring contractor. We refer particularly to the planning or lay-out of the positions of the various light sources rather than to the actual conduct of the installation. At present the architect is mainly responsible for this work, and it is only to be expected that it will, in the majority of cases, be carried out in perfunctory manner. It is too much to hope that architects as a body have added to the list of their studies the problems of not only electric light wiring, but also the greater complexities of electric illuminants. We have yet to learn that these matters are included in their course of training, sandwiched, so to speak, between classes on building construction and the strength of materials. Obviously, then, there is a place for a special electrical expert to fill, in tendering advice, to the architect presumably, on the best method of disposing the lights of the building he is preparing the plans for. We have, of course, hundreds of so-called consulting engineers who look after very large installations and give advice to archi-

STATOR OF 1800K.V.A. ALTERNATOR AT SIEMENS' STAFFORD WORKS.

tects, but they do not, to our knowledge, make a close study of illuminants or lighting, and are little better than consulting wiring contractors. The "man in the gap" is the expert who has had some experience in the manufacture of electric lamps, has studied light distribution, is familiar with wiring problems, and can bring a broad knowledge of all the facts to bear on each particular case as it comes before him. Such an one may well be termed an "illuminating engineer," and should be recognised under this title in the profession. With a class of expert advisers in the lighting industry like these the general standard of electric lighting would be materially raised, and the stigma which certainly attaches to it at present would be removed. A society of illuminating engineers has already been formed in the United States, and it starts with a very good membership roll, so that we can hope for something to be done in this direction over here before very long. The Institution would be able without much difficulty to set some such movement on foot, and it would further benefit by having such an association affiliated to itself. While it now fosters chiefly the heavier sections of the industry or those mainly concerned with the generation and distribution of electricity it would, if responsible for a society of illuminating engineers, broaden its basis and become more fully representative. We are convinced that the movement would not lack for support, as there are hundreds of electrical men now being turned out from technical institutions who would welcome new channels for their energies, and throw themselves with a will into work of a highly interesting and withal scientific character. Quite apart from students there are also many experienced electricians who could qualify for the position indicated, and who would quickly build up a reputation for themselves in this new and promising field.



TWO 1800K.V.A. ALTERNATORS ON HOPKINSON TEST, AT SIEMENS BROS'. WORKS, STAFFORD.

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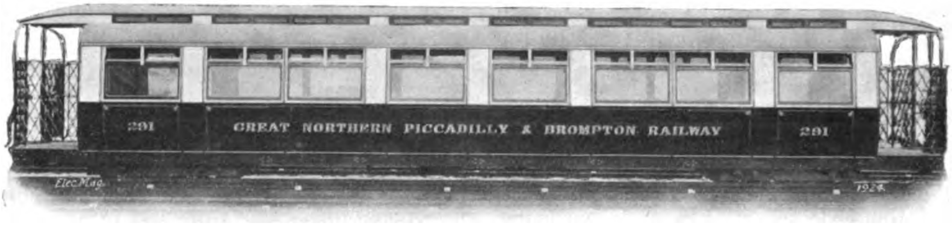
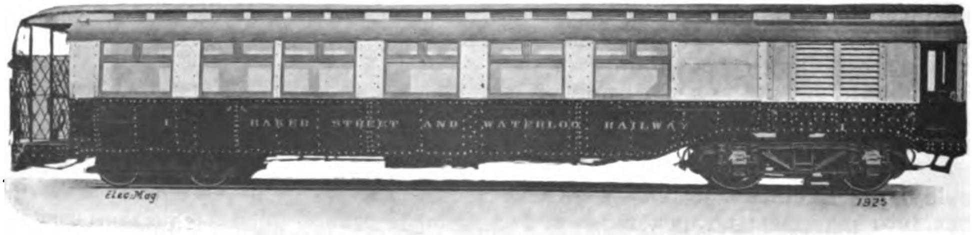
The Transports of London.

DURING the past month Londoners have witnessed the inception of traffic facilities which open up sections of the Metropolis hitherto lacking in adequate means of communication. The great scheme of



A British All-Steel Tube Railway Car for London.

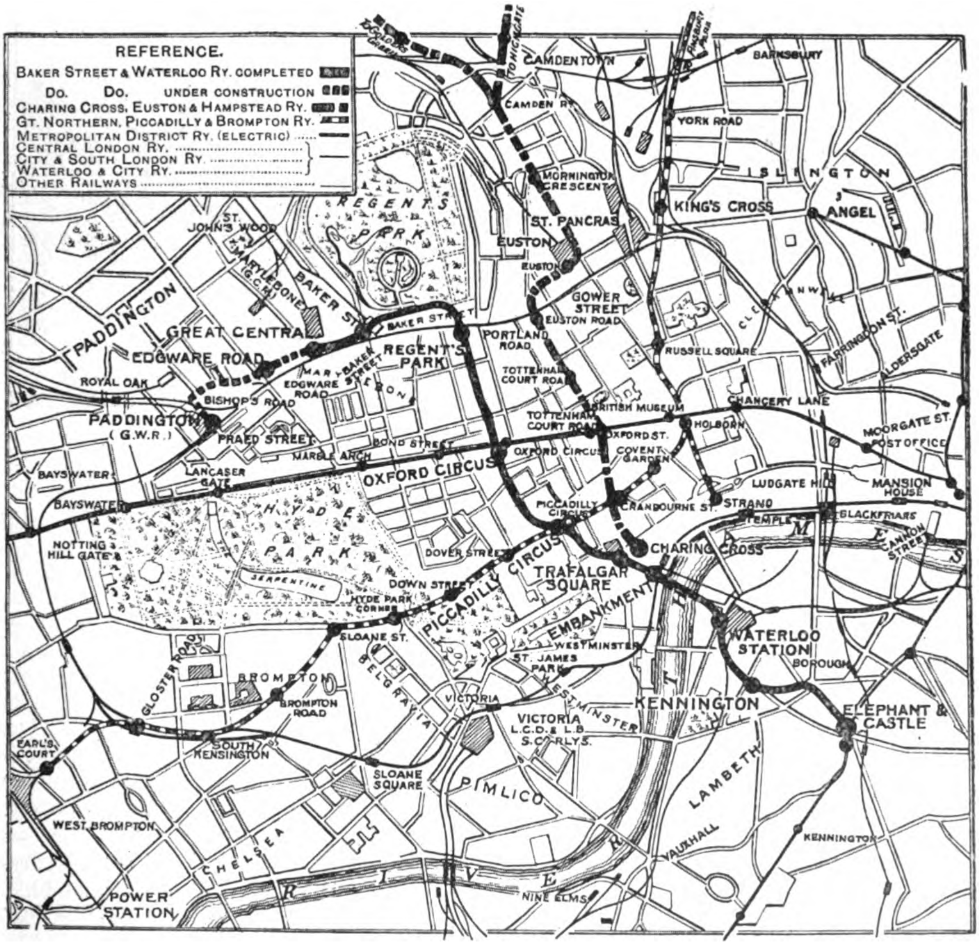
tubes now approaching completion will give to London an all-weather transport system which will be without rival in the world, and the first movement towards the inauguration of this has now reached consummation in the opening of the Baker Street and Waterloo Railway. This line has been building six years, and financial rather than engineering difficulties have delayed its completion. Electrically it presents no particularly striking features; it is a third-rail tube-line fed through rotary converters from the Chelsea power house of the Underground Electric Railways of London (Ltd.). The rolling stock is of American design, and we have taken the opportunity of comparing the all-steel cars with those of British make, and the superiority of the latter must be certainly conceded. Through the courtesy of the Brush Electrical Engineering Co., Ltd., we are enabled to make this highly interesting comparison. We also present a complete map, reproduced by courtesy of the Railroad Gazette, of the new line, and also of the existing tube routes, while in addition are given the tubes now under construction, which will link up London from all points of the compass. Another traffic innovation is the London County Council subway under Kingsway, in which single-deck tramcars are now running, carrying passengers from the Strand and Aldwych to Islington. The feature of this particular route is the subway under the roadway, and this, though not novel, is the first to be put in operation in London. The main portion is concrete construction, but under Holborn is a depression which is run in steel tubes. From this part of the track the cars travel up a steep incline to the street level. The line has been well patronized since opening, as a useful link between West Central and Northern districts of London. The above-mentioned routes are more important to Londoners than their mere situation on the map signifies. They commence the process of *i*-dotting and *t*-crossing in the tale of metropolitan transport, which must go on for a few months to make the narrative complete. A journey from west to east, and *vice versa*, has long been a simple matter, but to travel at right angles to this route with any comfort or celerity was a moral impossibility. The new tube and the subway have, however, materially altered that, and now it is possible to begin thinking that London is the first city in the world in the matter of efficient transport. Certain it is that the recommendations of the Traffic Commission are not likely to be needed when the entire tube system is in service. In fact, the formation of that august body is a matter now open to serious question.



An American All-Steel Tube Railway Car for London.

Heavy Electric Train Service.

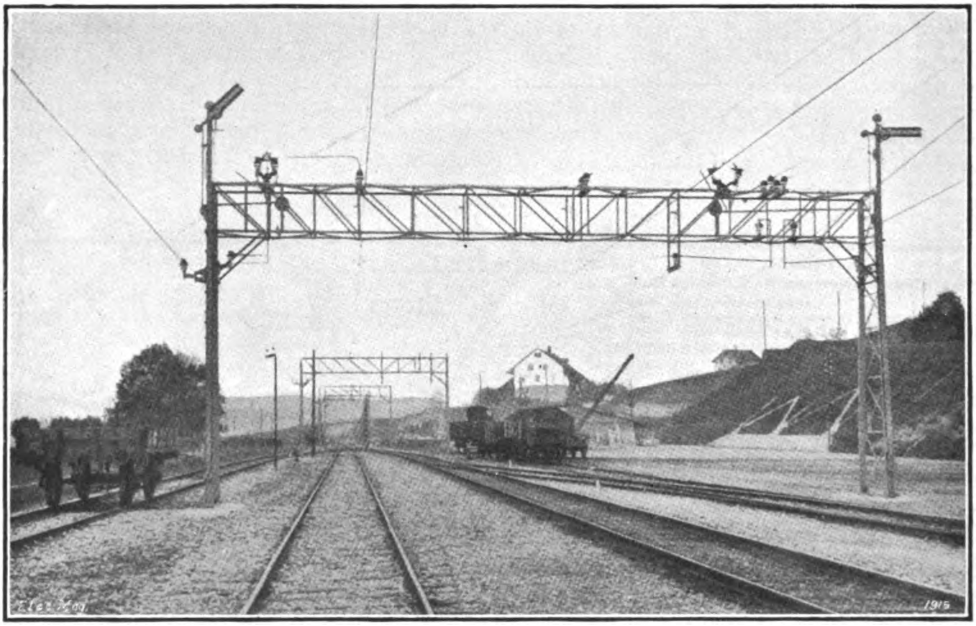
THE past month has produced a number of interesting and valuable contributions to the problem of main line electrification, and it is evident that a very close study of the subject is being made in the chief world centres of electrical activity. direct current will put up any severe competition against it. If getting a good start is any advantage then one-phase is certainly well ahead, and it is likely to maintain the lead, for the theory and construction of the alternating-current commutator motor are becoming better understood every day.



By kind permission of] [*the "Railway Gazette."*

MAP OF LONDON'S NEW TUBE—THE BAKER STREET AND WATERLOO—WITH NEIGHBOURING TUBE AND OTHER RAILWAYS.

We publish in the Traction section this month several important items bearing on the subject, notably a view taken by a prominent American expert as to the future of alternating-current methods. The case for one-phase working can be made very strong, and it is yet a matter for speculation whether three-phase and high-voltage What may be termed the "availability" factor will assume greater importance, and be more to the advantage of one-phase working as time goes on, because apparatus will have been standardised, and prices will be lower, while that all-engrossing matter of delivery, which is essential to a manufacturer's reputation, will weigh heavily in favour of one-



15,000 Volt Lines on Swiss Experimental One-phase Railway at Seebach.

phase apparatus. The trials of heavy locomotives now being held under severe operating conditions should be closely followed by railway engineers, as, if nothing else, they go to prove that the problem is being attacked on the right lines. Not only are the builders of electric locomotives willing to run their machines through snow and water, but they are operating them from extra high voltage lines subjected to the most severe tests for capacity and reliability. An interesting and significant movement is that of providing an electric service of locomotives for operation in long tunnels formerly plying steam-hauled trains. This is a step in the right direction, and will be a species of piecemeal electrification which should furnish evidence for the general conversion of long stretches of track. The Simplon tunnel will shortly be traversed by trains drawn by three-phase locomotives, and other important installations will soon dispense with the soot and grime of steam, and traffic will be accordingly more brisk over those routes. In tunnels beneath the bed of rivers which are approached by steep inclines, the question of regeneration of energy becomes important, as the installation cost could be materially reduced if motors having a recuperative factor were employed. With two tracks the trains could be timed to enter the tunnel from opposite ends, so that they could pass on the one grade, and the descending train would then assist that climbing the outward slope, relieving the power house of much of the load of the ascending train. At present three-phase motors and one-phase induction motors are alone suitable in this capacity, the latter being used on the motor-generator system similar to that of Ward Leonard. The alternating-current series motor has no such characteristic, and is consequently unsuited for regenerative purposes. The recent severe weather has given experimenters with electric locomotives ample opportunity of testing them under conditions which will have to be faced if such machines ever reach the stage of supplanting the steam types now in use. In the Traction section this month will be found some interesting details of the effects of snow on the third rail, and the performance of a direct-current locomotive through snow-drifts and ice-covered tracks. Sleet has always been a frequent cause of stoppage with the over-running third rail, and although the snow tests with the under-running type are useful they prove nothing as regards sleet, though the inversion of the collecting surface should mitigate the evil to a great extent.

POWER: and·its·application·to· INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Electric Cold-storage and Ice-making Plants.

By S. F. WALKER.

Electricity has been adopted a good deal for driving compression plants, but principally for small plants up to the present, such as those for dairy work, tradesmen's plants, hospitals, &c., but there is no reason why it should not be employed for larger plants where the price of current is favourable. Where large plants are installed there is usually steam on the ground, and the tendency is to either drive the refrigerating apparatus by a strap from a shaft that is doing other work or to put up a separate engine taking steam from the main boilers. Gas is also a formidable competitor, as in other cases. Where the electricity supply is constant, in the full sense of the term, it should make a better drive because it is steadier. In ice making the ice suffers in appearance and in quality if the speed of the compressor varies much, and the same thing holds in cold storage. The preservation of produce is gradually extending to almost everything, not only what we eat, but some things that we wear, such as furs, and to tobacco, and other commodities, but it is important that the temperature at which they are held shall be maintained fairly uniform. It is better for the temperature to go up slightly in many cases than to go down, but both are bad. There is a certain temperature at which the processes that mean decay are arrested, but at which the substance itself is not damaged. If the temperature is lowered much below this figure the substance may be seriously damaged, while if it is allowed to rise a few degrees above the processes of decay may commence and cannot afterward be stopped.

It will probably be understood from the above that the power required for each case must be calculated by itself. The following figures from practical work will complete the matter: The one-ton machine, when running the full twenty-four hours, will hold a room of 1500 to 3000 cubic feet capacity at thirty-two degrees Fahrenheit, the two-ton machine a room of 3000 to 6000 cubic feet, and so on; a twenty-ton machine holds a space, which may be occupied by several rooms, of 1,000,000 to 2,000,000 cubic feet at thirty-two degrees Fahrenheit. They will hold larger spaces at higher temperatures and smaller spaces at lower temperatures. It should be mentioned that the power goes up rather rapidly as the temperature at which the room is to be held decreases after a certain limit is passed. The sizes of ammonia and sulphurous acid compressors are approximately the same as those of the steam engines that are required to drive them, those of carbonic acid machines are very much smaller. For small plants the electric motor is frequently mounted on the same bed-plate with the compressor, which it drives through spur gearing, and there is no reason that this should not also be done with large apparatus in the same way as with so many other machines of various kinds. Belt driving, however, has been resorted to a good deal. The smaller refrigerating plants are also often made self-contained; that is, the condenser, the evaporator, the compressor and pumps are arranged in one unit, the condenser and evaporator occupying tanks one inside and insulated from the other, the compressor and accessories being mounted on the outside of the outer tank. The crank shaft is then fitted with a pulley if a separate drive is intended, or the driving engine is mounted with the compressor on the outside of the outer tank.

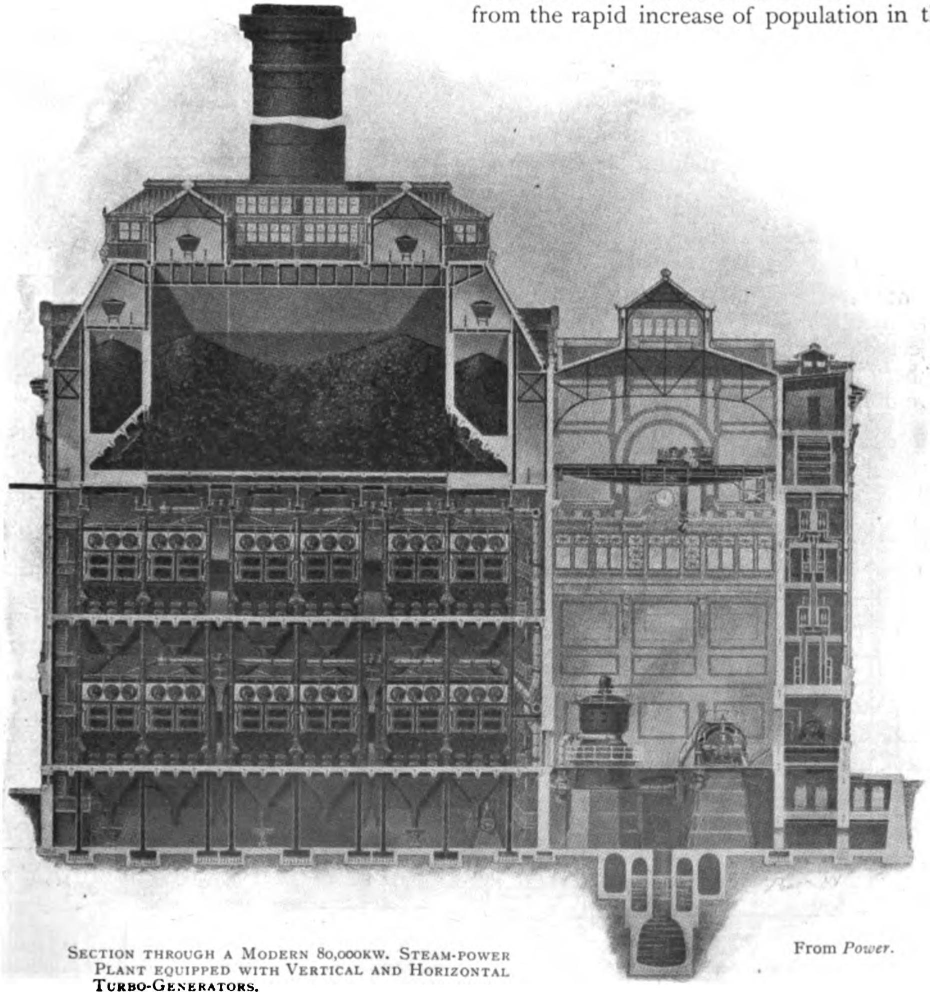
As is well known in the absorption process the ammonia gas is forced out of an aqueous solution by the action of heat. Water dissolves ammonia and other gases in a certain ratio varying inversely with the temperature. The absorption apparatus, therefore, consists of two vessels in one of which a strong solution is maintained, from which the gas is being continually driven off; the other, known as the absorber, receiving the gas which has done its work in the evaporator coils and redissolving it. A continuous exchange goes on between the two vessels, the weak solution passing to the absorber and the strong solution passing to the generator. Steam is the heating agent at a temperature of 300°.

It appears to the writer to be worth the consideration of electrical engineers whether it may not be possible to displace steam by electricity. There will be the old objection that has been so often made and in the face of which electricity has made such important progress, that it cannot be so economical to use electricity in place of steam when the electricity itself has to be generated by the aid of steam. But it is by no means certain that this expresses the whole of the problem. If the steam passed directly into the aqueous solution it would be correct, but it does not, it passes in pipes through the solution and only a certain proportion of the heat carried by the steam, and a small proportion at that, passes into the solution, while if the solution were heated by resistance coils, the whole of the heat would pass into it. In addition to this the use of electricity would avoid one possible source of inefficiency especially where the machine does not receive careful attention—viz., the leakage of steam into the solution. The absorption apparatus is rendered very much more complicated than it otherwise would be by the fact that when the ammonia gas is driven off some water goes with it, which has to be eliminated before the gas passes to the condenser, and this is increased whenever leaky joints allow steam to escape directly into the solution.—Elec. Rev., N.Y.

Niagara Power Situation.

CONSIDERABLE interest attaches to the possible outcome of the present agitation in the United States and Canada as to what shall become of Niagara Falls. We have already indicated the extent of the power development at that spot, and the possibility of further encroachment on the waterfall by interested concerns. Mr. O. E. Dunlap, in the columns of the Western Electrician, says: "Up to this time the output of the Niagara power-houses has been confined to a radius of 34 miles; practically to 25 miles. Now transmission lines are being erected to carry the power to Syracuse, 160 miles distant from the point of development, and to Toronto, Ontario, 85 miles away. Between these points and Niagara there are numerous available markets of considerable size, so that for the entire distance, on either side of Niagara, there may be a demand for the transmitted power. The possibilities of economical transmission of electrical power should increase, and, if so, then the assault, if such it may be termed, that is to-day being made on the power development interests is of importance to a still wider circle than that outlined, and the future industrial prospects are threatened. At this writing none of the power companies has made any response to the various Bills, resolutions, and suggestions of enterprising legislators, but there is good prospect that they will have their innings shortly. The question affects not only the power companies, but also the industrial future of New York State, and possibly other States, and of the province of Ontario. The effects of the development made have been far-reaching, and so must the results be in any abbreviations of Niagara's greatness. Lord Kelvin says: "I do not myself believe that any such limit (450,000h.p.) will bind the use of this great natural gift, and I look forward to the time when the whole water from Lake Erie will find its way to the lower level of Lake Ontario through machinery doing more good for the world than that great benefit which we now possess in the contemplation of the splendid scene which we have presented before us at the present time by the waterfall of Niagara. I wish I could think it possible that I could live to see this grand development."

In the following issue of our contemporary, the discussion of the subject was continued by a prominent Canadian, who remarked among other things: "There is a lot of loose talk about an international treaty for Niagara's preservation. This comes of the obvious lack of power in New York State and in Ontario to agree firmly and permanently upon a preservative policy. It is preposterous to imagine that Sir Wilfrid Laurier will fail to bargain shrewdly and tenaciously for those material and political interests that would be given away by an international agreement securing the present power situation, or by conceding gratis to New York, or to the United States, an equality in Niagara exploitation. About one-thirteenth of the river's minimum flow is being diverted from the cliff, and passed around the falls into the lower river by tunnels. The power companies are now rapidly installing more plants, with design to utilize soon one-fifth of the minimum flow. Such additional concessions are sought, and such sites for future water draughts authoritatively located, that diversion of 67 per cent. of the minimum or 50 per cent. of the maximum flow is clearly meditated. The demand for Niagara power swiftly increases and will probably increase more swiftly. It may not during the next few years overtake the supply of 615,000 electrical horse-power that could be collectively generated by the various plants now installed or in course of installation. But meantime imminent competition seems likely so to lower the price of electric power as to attract to the Niagara region many of the new industrial establishments that are ever arising from the rapid increase of population in the



SECTION THROUGH A MODERN 80,000KW. STEAM-POWER PLANT EQUIPPED WITH VERTICAL AND HORIZONTAL TURBO-GENERATORS.
By kind permission of the Hill Publishing Co.

From *Power*.

Republic and the Dominion, as well as many of the going concerns whose owners contemplate, from time to time, renovation or enlargement of plant. The problem of Niagara conservation involves not only bringing the Washington and Ottawa Governments to conference for a truly preservatory treaty, but the education of the American public to a perception that Canada may fairly claim some important concessions in return for agreeing so to limit the exploitation that no more Niagara water may be taken than has been conceded already. Were such an agreement internationally made, then surely the existing concessionaires ought to be smartly taxed for the monopoly thus secured to them in nominal perpetuity."

* * *

Industrial Motor Applications.

THE advantage of the electric drive in the wide field of industry is now well understood, and from this broad generalization information and data are being collected and prepared giving details of the application of motors to various special trades and processes. Mr. W. J. Belsey in a paper recently presented before the Dublin I.E.E. gave some useful and well-classified data on the subject of motor driving, and we append a number of typical power tables which should prove useful for reference.

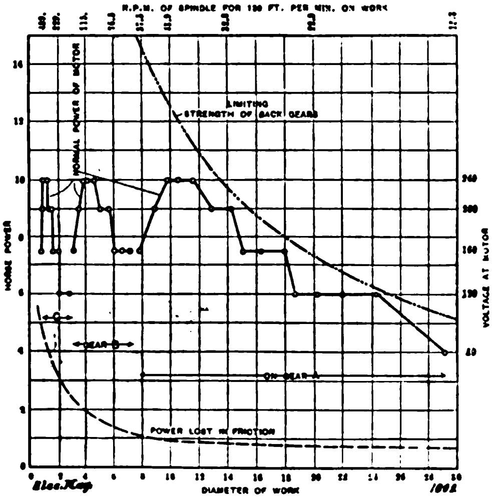


FIG 1. POWER CURVE FOR 30IN. LATHE OPERATING AT 120FT. CUTTING-SPEED PER MIN.

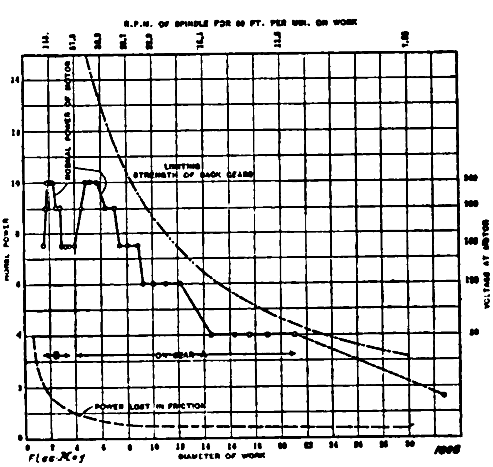


FIG. 2. POWER CURVE OF 30IN. LATHE OPERATING AT 60FT. CUTTING-SPEED PER MIN.

Lathes for Screw-cutting and General Work.

Height of Centre.	Distances between Centres.	Rating of Motor.
4½ to 6in.	20 to 32in.	¼b.h.p.
7 to 8½in.	36 to 80in.	½b.h.p.
8½ to 12½in.	40 to 100in.	1 b.h.p.
14 to 16½in·	100 to 140in.	1½b.h.p.
16½ to 19 in.	140 to 175in.	2 b.h.p.

Face Lathes.

Diameter of Face Plate.	Largest Working Diameter.	Rating of Motors.
30 to 50in.	48 to 64in.	2b.h.p.
60 to 63in.	64 to 93in.	3b.h.p.
80 to 100in.	106 to 140in.	5b.h.p.
158in.	212in.	10b.h.p.

Turret Lathes (working with One Tool.)

Height of Centre.	Largest Working Diameter.	Greatest Work in Length.	Rating of Motor.
9 in.	20 in.	33in.	1b.h.p.
11½in.	24 in.	43in.	3b.h.p.
11¾in.	25½in.	33in.	2b.h.p.
13 in.	28 in.	55in.	5b.h.p.
16¾in.	34 in.	63in.	5b.h.p.

Horizontal Boring Machines.

Greatest Height of Bar.	Largest Working Length.	Rating of Motor.
21 to 25in.	40 to 60in.	1½b.h.p.
33 to 35in.	80 to 140in.	2 b.h.p.

Drilling Machines.

Pattern.	Maximum Diameter of Work on Table.	Greatest Distance from Spindle End to Table.	Rating of Motor.
Quick speed...	6 to 10in.	9 to 35in.	½b.h.p.
Pillar	10 to 13in.	32 to 48in.	1 b.h.p.
Radial	40 to 72in.	46 to 80in.	2 b.h.p.
Three-spindle	6 to 6in.	31 to 35in.	1 b.h.p.

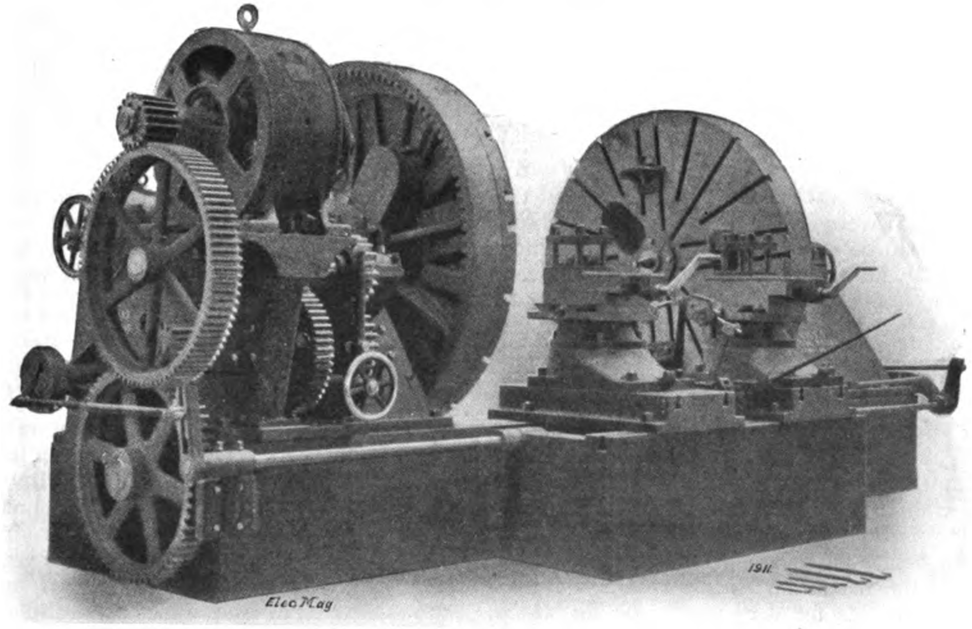
Grinding Machines.

Diameter of Emery Wheel.	Rating of Motor.
Up to 10in.	½b.h.p.
10in. to 14in...	1 b.h.p.
14in. to 22in...	2 b.h.p.

Pneumatic Hammers.

Weight of Tup with Piston.	Length of Stroke.	Number of Strokes per Minute.	Maximum Height of Work.	Rating of Motor.
165lb.	11¾in.	220	4¾in.	3 b.h.p.
275lb.	14½in.	200	7 in.	4½b.h.p.
440lb.	17¼in.	180	8¾in.	6½b.h.p.
660lb.	19 in.	170	10¼in.	8 b.h.p.
1,000lb.	21½in.	150	11¾in.	10 b.h.p.
1,425lb.	23 in.	130	13¾in.	12-15b.h.p.
1,870lb.	27 in.	110	15¾in.	17-20b.h.p.

The subject of machine tools and workshop economy was also recently taken up by Mr. E. R. Douglas before an American technical society, and from this we extract the following.

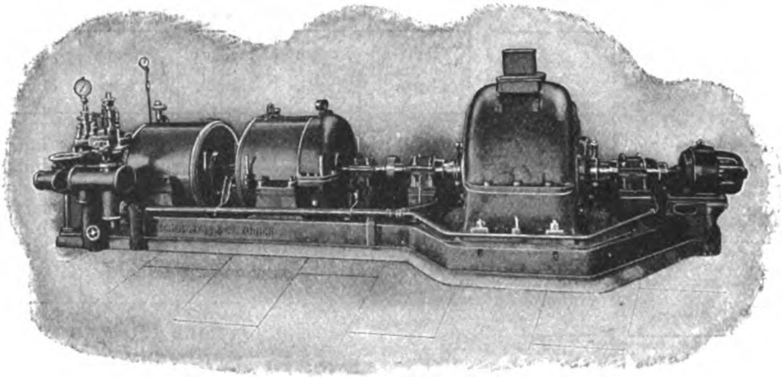


A Typical Motor-driven Wheel Lathe as used in Railway Workshops.

Planing Machines.

To Plane in Length.	To Plane in Width.	To Plane in Height.	Rating of Motor.
40in.	26in.	26in.	1 b.h.p.
72in.	24in.	24in.	1½b.h.p.
84in.	26in.	24in.	3 b.h.p.
120in.	38in.	38in.	5 b.h.p.
120in.	49in.	49in.	7½b.h.p.
168in.	60in.	60in.	10 b.h.p.
192in.	73in.	73in.	10 b.h.p,
206in.	105in.	105in.	10 b.h.p.

The benefits resulting from the motor equipment of an ordinary thirty inches back-geared lathe can advantageously be considered. The speed requirements of such a lathe are, first, to cover the range in diameters of work which may be done on the lathe, which may be from the smallest up to thirty inches, and, second, to cover a range in cutting speeds required for different kinds of cuts and for materials of different hardnesses which may be worked on the lathe.



A Modern Zoelly Steam Turbo Set of 600B.H.P.

In passing, a convenient formula may be given:

$$HP = VSK$$

where HP is the power required, V is the amount of metal removed in cubic inches per minute, S the cutting speed in feet per minute, and K a constant depending on the material. K varies for cast iron from 0.25 to 0.4, for steel from 0.4 to 1. To the horse-power at the tool must be added the power to overcome the friction of the machine. This can be estimated only from experience. It may be stated that the constants given, while applicable to cutting tools similar to those used in lathes and planers, do not apply to milling cutters where the rubbing friction between the tool and the surface cut increases the power requirement greatly.

Suppose that, on the thirty-inch lathe to be considered, 120ft. per minute be the maximum allowable for soft machine steel at finishing cuts, and that for roughing cuts sixty feet per minute is the fastest that can be used. There are generally required not only the maximum cutting speeds, but also lower speeds for occasional jobs for which the power requirements will also be lower. It is convenient to have speeds down to thirty feet per minute, making the range thus far obtained 120ft. to 30ft. per minute or 4 : 1. The maximum speed of the lathe is generally limited by mechanical difficulties, due to vibration and heating of bearings; 500 revolutions per minute may be taken as this value. This speed is chiefly useful for polishing, but corresponds to 120ft. per minute on about nine inches diameter, and could be used for that. A diameter as small as this, however, would not very often be put on such a large lathe. The other extreme of the diameter range is the requirement of 120ft. per minute on thirty inches diameter. This corresponds to 15.3 revolutions per minute. The speed range to cover variations of diameter is therefore from 500 to 15.3 revolutions per minute or about 33.1. The total range would be the product of the two, namely, four times thirty-three, or 133 : 1. The maximum speed being 500, the minimum would then be about four revolutions per minute.

The power charts of this lathe are given in Figs. 1 and 2 for speeds of 60ft. and 120ft. per minute, and afford an excellent example of the work required of the motor under somewhat severe conditions.

◆

Power from Lake Michigan.

Six hundred thousand cubic feet of water per minute will presently flow from lake Michigan to the Mississippi river. In its course of 325 miles across the state of Illinois this water will fall 176ft., and thus transform energy at the rate of 200,000h.p. This great water power, if electrically developed and transmitted, is probably sufficient to displace every stationary steam engine in Chicago and the remainder of the state.

Power development on this great scale has been made possible by the construction of the Chicago Sanitary and Ship Canal from lake Michigan to Lockport, a distance of thirty-four miles.

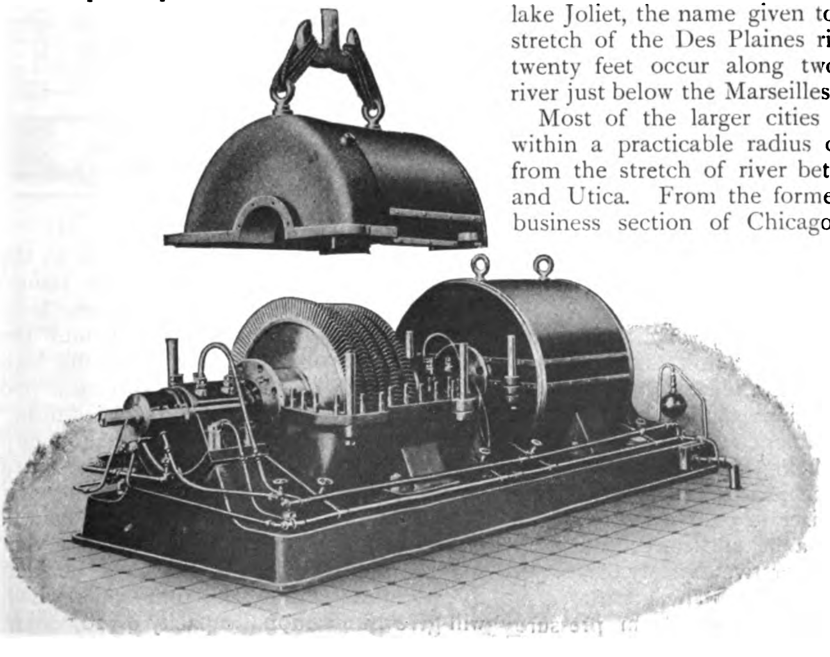
Fortunately for the useful development of power with this water of the great lakes, most of its fall occurs along a small part of its course to the father of waters. From Robey Street, in Chicago, to the controlling works, at Lockport, the canal lies entirely in excavation through the Chicago divide that separates the lake Michigan watershed from that of the Mississippi, and substantially the lake water level is available at these works. From the controlling works at Lockport to Utica, a distance of sixty-two miles, the fall of the Des Plaines and Illinois rivers is 140ft., while from Utica to its mouth on the Mississippi the Illinois river falls only thirty-six feet in its course of 229 miles. That part of the river channels between Lockport and Utica is thus the only one suited to power development. In falling 140ft., along this sixty-two miles of river the 600,000 cubic feet of water diverted from Lake Michigan per minute develop 160,000 gross h.p. With good hydraulic works as much as sixty per cent. of this gross power, or 96,000 electric h.p., may be developed twenty-four hours a day for transmission to Chicago and other cities. Opportunities for power development are not equally good along this sixty-two mile stretch of river, for much the greater part of the descent occurs between Lockport, at the brow of the Chicago divide, and the junction of the Des Plaines and Kankakee rivers, in a distance of twenty-one miles.

These opportunities for water-power development along the Des Plaines river are not lying neglected, but one of them, at least, is soon to be utilized to generate electric energy for use in Chicago. About two miles from the controlling works at Lockport, the sanitary district of Chicago, a municipal corporation of Illinois is now building an electric-power plant that is to have an ultimate capacity of 35,000h.p. This energy is to be transmitted to Chicago and other points in the district. A canal 10,700ft. long conveys water to this generating station from the controlling works, and another canal 6800ft. long acts as a tail race to discharge the water into the Des Plaines river. In this way a mean head of thirty-two feet is maintained for the water-wheels. There will be ten sets of these wheels on as many horizontal shafts, three sets for the exciting dynamos and seven sets for the main generators. Each set of main turbines is rated at 6500h.p. at full gate under thirty-four feet of head and at 150 revolutions per minute. At 8/10 discharge each set of main wheels is designed to pass 100,000 cubic feet of water per minute, and the ultimate discharge of the power plant is expected to reach 800,000 cubic feet per minute.

In Joliet, about eight miles down the Des Plaines river from Lockport, the sanitary district has done a large amount of preliminary work in the way of excavation for the purpose of another water-power development.

Below Joliet, on this river, it seems that the electric development of the water power may still be open to private enterprise, and from this city to Utica the fall amounts to sixty-six feet in a distance of fifty-four miles. Of this total fall about fifteen feet is concentrated in a distance of three miles below lake Joliet, the name given to a nearly level stretch of the Des Plaines river, and some twenty feet occur along two miles of the river just below the Marseilles dam.

Most of the larger cities of Illinois are within a practicable radius of transmission from the stretch of river between Lockport and Utica. From the former place to the business section of Chicago is less than



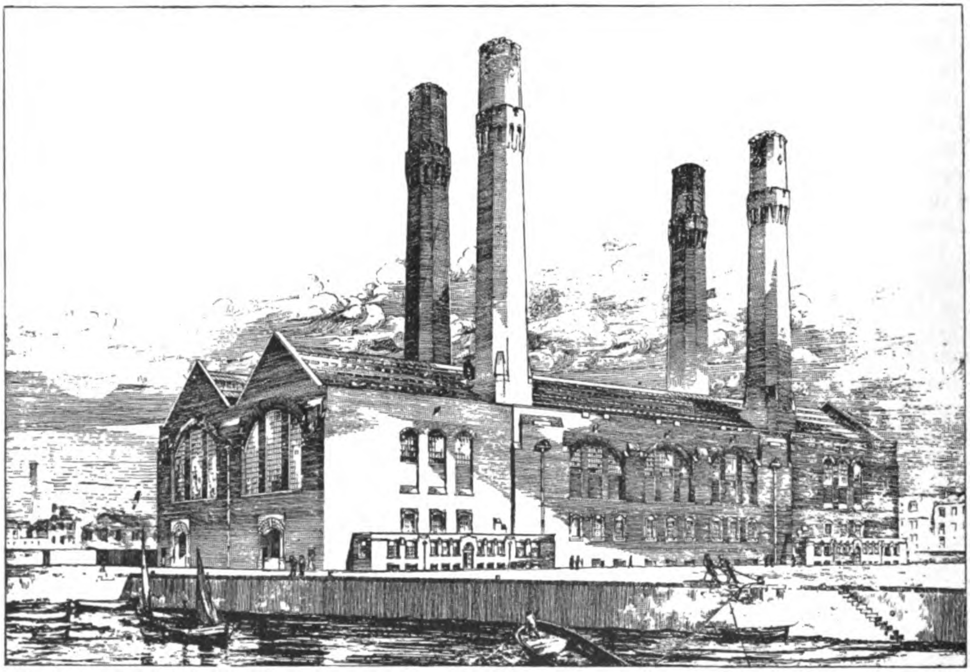
THE LATEST ZOELLY STEAM TURBINE, WITH WHEEL-CASING REMOVED, SHOWING VANES.

This illustration and that opposite are taken from Mather & Platt, Ltd.'s, recent publication on Steam Turbines.

thirty-four miles. Elgin and Aurora are within a forty-mile radius of the same point, Peoria is about eighty miles, Bloomington seventy-five miles, Rockport eighty miles, Rock Island 110 miles and Springfield 143 miles, in a direct line, from the dam at Marseilles.—A. D. Adams in Elec. Rev. N.Y.

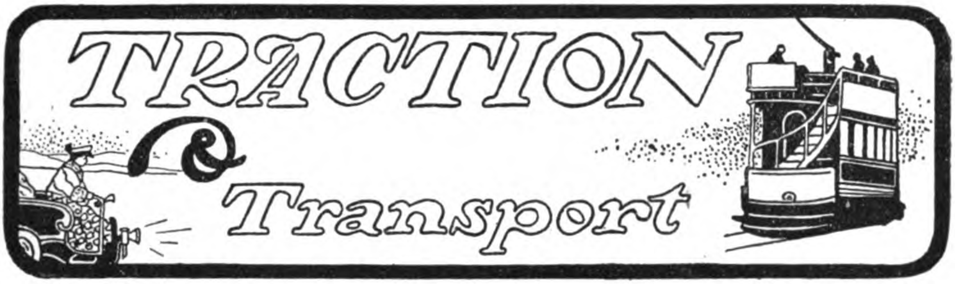
L.C.C. Tramway Power House.

The Greenwich station which is to take up the tramways load of the L.C.C. system was designed several years ago, and as a consequence its first section comprises heavy reciprocating units which are not at the present time specified for power-house equipment. The station, which will commence running its first unit about Easter, includes four 3500kw. units driven by horizontal-vertical engines similar to those used in several large American stations. Twenty-four boilers are being installed as the initial equipment, with chain grate stokers, and a 320-lb. tube economizer to each pair of boilers. Each boiler has a heating surface of 3650 sq. ft. and an evaporative capacity of 16,300 lb. of water per hour. The grate area is 60 sq. ft., and the normal steam pressure will be 200lb. per sq. in. The steam piping is arranged to give a regular fall from the boiler stop valves to the engine separators, and natural gravity drainage is allowed for at any point. The alternators are three-phase machines, giving 350 amps. per phase at 6600 volts, 25 cycles, and a power factor of 94 per cent. They are revolving field machines, and the field system constitutes the engine flywheel. There are thirty field poles, and the windings are of copper tape on edge.



The 34,000kw. Steam Station of the L.C.C., at Greenwich, as it will appear when completed.

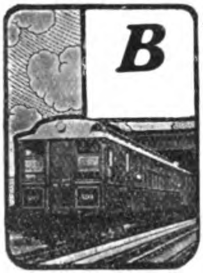
Surface condensing plant is being installed with motor-driven air and circulating pumps, the circulating water being drawn from the Thames, on the banks of which the station is built. The control arrangements have been carefully planned, and include the latest remote operated devices on the high voltage side. A battery has also been laid down for stand-by current for the electrically operated switch gear and for excitation purposes. We shall return to this subject in a future issue, when a more complete description of the plant will be given. We will conclude this short note by remarking that the engineer, Mr. J. H. Rider, has decided to extend the station with turbo-units, which will give an additional capacity of 20,000kw.



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Electric Traction by Alternating Currents.

By Dr. LOUIS BELL.



By far the most interesting development in electric traction during the past two years has been the introduction of the alternating-current motor, both in America and Europe. Its appearance was nearly simultaneous in the United States, Italy, and Germany, by methods closely similar. The publication of Dr. Finzi's experiments served to stir up the others who had been working on the problem, and to do justice to the American contingent, its work was probably ahead of the rest. The immediate result has been the equipment of perhaps a dozen roads of the smaller sort, and what is far more sensational, the ordering of alternating-current locomotives on a large scale by the New York, New Haven and Hartford Railroad Company. It is this last move that has stirred up the most active discussion in engineering circles.

Now the fundamental question to be asked in the premises is this : "Why should any engineer prefer an alternating-current motor for electric traction when he already has exceedingly good direct-current motors?" And the answer is an exceedingly simple one. Engineers do not prefer the alternating-current motor as such, but because by its means it becomes easy to do certain things which are practically out of the question so long as one adheres to direct current.

The fundamental advantage of alternating current for nearly all purposes lies in the fact that energy in such form can be changed in voltage to any required extent by very simple apparatus at very high efficiency. The alternating-current transformer costs considerably less than half as much as any form of electric generator, and transforms the energy received into energy of different voltage, at a loss of only two to three per cent. Hence, by carrying about a piece of apparatus neither very costly nor very heavy, one can receive from the line energy at very high voltage and deliver it to the motor at whatever lower voltage may be required. The alternating-current motor in itself is not especially suitable for high voltage, but the combination of transformer and motor can not only work on a high-voltage circuit, but on the motor side can be operated with as wide a range of voltage as may seem desirable for the purpose of regulation.

Since the amount of copper required to transmit, let us say, the energy for a car over a given distance varies inversely as the square of the working voltage, the loss remaining the same, it is clear that to deliver power to a car at 2500 volts requires only one twenty-fifth as much copper as at 500 volts. In other words, excluding some minor considerations, there is an enormous gain in the cost of delivering energy to the cars if one works at the high voltage used with the alternating-current system.

The series of energy transformations in a typical electric-railway case by the two methods respectively is as follows. Present system : Generator—high-voltage line—reducing transformers—rotary converter—low-voltage line—motor. Alternating system : Generator — high-voltage line — reducing transformer (on car)—motor. This series omits the two steps which in the former are particularly serious in cost and in loss of energy. The saving in energy alone would in the ordinary case be some 20 or 25 per cent. It needs no argument, therefore, to show that such a change would be in and of itself extremely desirable.

In addition the supply of energy at high voltage from the working contact conductors very greatly simplifies the collection of current by the contact devices. At the customary working voltage of about 600, the current necessary to drive a modern interurban or suburban train amounts to several hundred amperes, a quantity which it is extremely difficult to obtain from an overhead trolley wire without very troublesome sparking and burning at the contacts. Hence many roads have been driven to the use of the third rail, which is a continual source of danger both to operation and to life, and which is extremely difficult to insulate adequately. At high voltage the necessary current proportionately decreases so that in the Zossen tests of a couple of years ago the heavy cars requiring at the higher speeds an input of 2000h.p., received their energy from three slender overhead wires each about the size of a lead pencil. So far as simplicity, efficiency, and cost of the conducting system is concerned, there is everything to gain and nothing to lose in using alternating current.

The rail return circuit undoubtedly has considerably lower virtual conductivity for alternating than for direct current, but this difference is more than offset by the fact that with alternating currents the electrolysis—sometimes very formidable with direct current—is of small moment.

Under these conditions it is not surprising that alternating-current traction has been vigorously pushed, and the sole reason for its relatively small development up to the present time must be sought in the difficulty of designing proper motors. To be sure, there have been a number of successful three-phase roads abroad using induction motors on the cars, of which the best known is the Valtellina line. The fact that a three-phase line requires at least two working conductors has been a serious objection in the eyes of American engineers mindful of the exasperating early experience with direct-current double-trolley lines. A more valid reason for wishing to dodge three-phase motors for traction is that they have but a single economical speed—that near synchronism. Speed regulation can be obtained by the use of rheostats on the same terms that are familiar in the rheostatic control of an ordinary direct-current railway motor, but in recent years this has been almost entirely superseded by the more economical series-parallel control, for which no proper equivalent is available in using induction motors. The so-called "cascade" arrangement of induction motors is far inferior to the regular series-parallel connection.

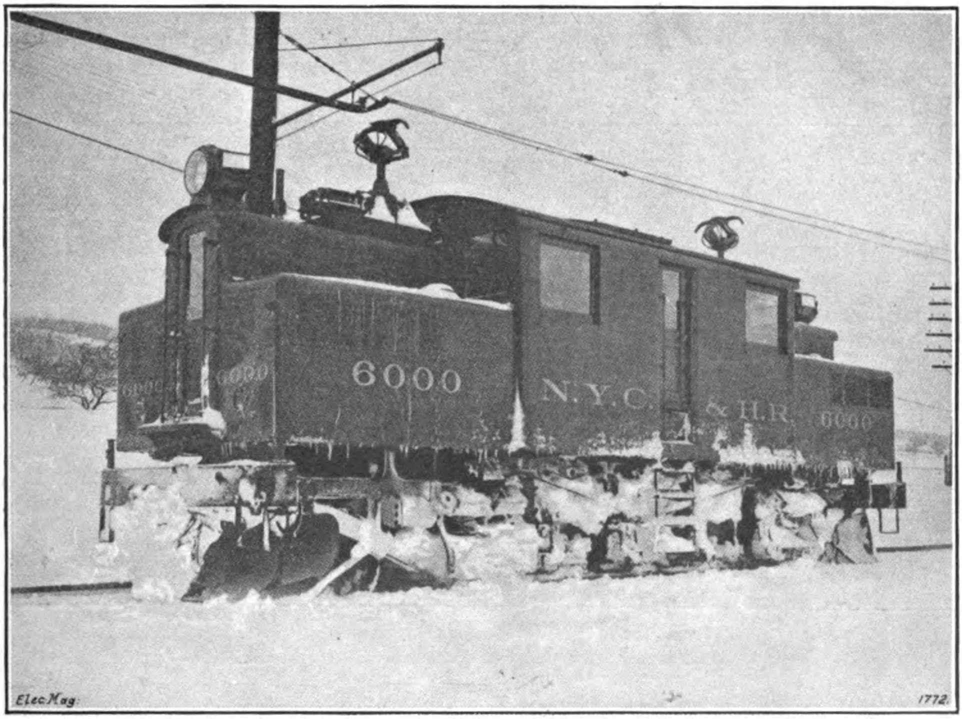
For a general solution of the alternating-current traction problem, then, it has seemed best to turn away, temporarily at least, from the otherwise very attractive induction motor, and to have recourse to motor systems capable of being operated from a single alternating-current working conductor. One such system which cannot be passed over without serious consideration is that brought forward some years ago by H. W. Leonard and since somewhat developed experimentally abroad. The scheme gives a far more perfect and delicate speed control than any other yet devised, and an efficiency high compared with that of the usual complicated plan of distribution. It is, however, open to the objection that the equipment required cannot be stowed away under a car, and gives considerable weight to be carried. If the very ingenious "permutator" recently developed should meet the hopes of its friends, the weight situation would be very greatly relieved, and the fact is that for the heavy railway work in which locomotives are desirable the Leonard system has some extremely strong points which it is not the part of wisdom to overlook.

But for the ordinary routine work of electric railways it has been necessary to turn to an entirely different type of machine—the single-phase commutating motor. This machine is based on the simple fact that a series-wound direct-current motor does not change its direction of rotation if the current through it is reversed, but only if the relative direction in armature and field is reversed. Hence such a motor will work on a circuit in which the current periodically reverses direction if the conditions are not too severe. The requirements for success are lamination of the field magnet as well as the armature, in order to prevent great loss of energy from eddy currents; very low inductance, so as to allow the passage of heavy alternating currents without causing serious inductive troubles in the system; and finally, extraordinary care in the design of the commutator to prevent destructive sparking.

The single-phase alternating-current motor has two inherent difficulties which no amount of finesse can entirely circumvent. In the first place, there is necessarily a loss from hysteresis in the iron and from residual eddy currents that renders the machine clearly less efficient than a direct-current motor of the same output, by an amount that may be roughly estimated at between 5 and 10 per cent. Second, owing to the fact that the energy supply derived from a simple alternating current is intermittent, the output of such a motor is, other things being equal, less than that of a direct-current motor of the same effective weight of material, by 25 per cent., more or less. As single-phase motors are practically built, the great care in design and the high grade of magnetic material used tend to lessen the differences both of efficiency and of weight here referred to, the inherent disadvantages being thereby transferred to the cost.

As regards speed regulation, the alternating-current motor has rather the advantage, since by using a transformer capable of supplying various secondary voltages the motors can be worked over a wide range of speed without recourse to rheostatic control.

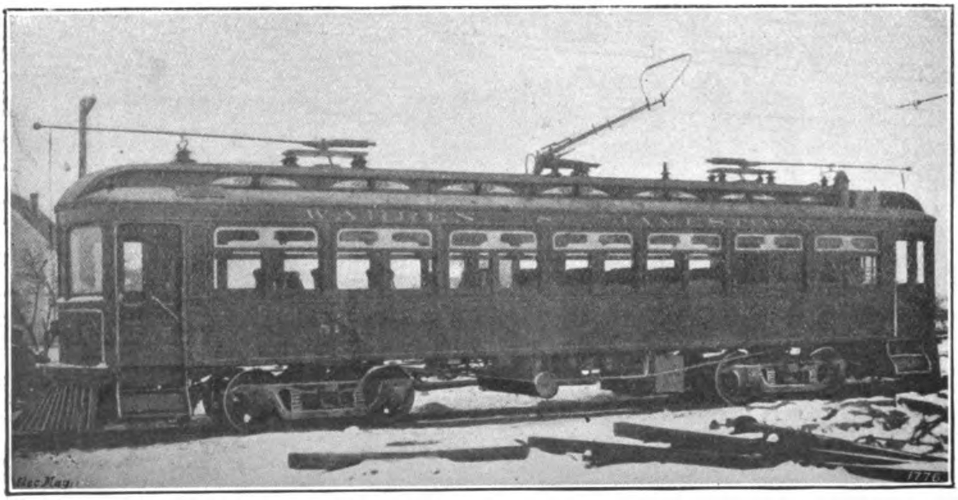
As may be judged from the principles of the alternating-current commutating motor, it can be used upon a direct-current circuit of proper voltage with good results. This advantage has been made much of in recent discussions—rather more, in fact, than can fairly be justified. It is quite true that the motor works easily on either kind of circuit, but the specialisation of the structure for alternating current is not altogether advantageous for direct-current working, and the duplicate use produces enormous complication in the wiring and controlling devices, including even the current collectors, of which one must be for high voltage and the other for low. Certain parts of the controlling apparatus may be made to serve in both cases. The fact is that while the duplicate use is entirely feasible it is not exactly simple and convenient, so that most



THE FAMOUS EXPERIMENTAL LOCOMOTIVE FOR THE NEW YORK CENTRAL ELECTRIFIED LINES, AFTER A TRIAL RUN THROUGH SNOW DRIFTS (see page 175).

engineers are disposed to look upon it somewhat dubiously, as a convenient stop-gap rather than a measure of permanent value.

In summing up the alternating-current traction situation one sees, first, that the new method has its chief and commanding advantage in the greatly simplified distribution—an advantage that rises in importance with every extension of electric traction into wider fields. Extension of electric traction to trunk-line and general railway work may be regarded as practically out of the question with the so-called "standard" direct-current methods. Higher voltage on the working conductors is imperative—so much higher as practically to preclude the use of direct current up to the car. The kind of transforming apparatus and motors used on the cars are of far less importance, especially in the big work just referred to, for which electric locomotives would naturally be used.



Interurban Electric Car, equipped with A.C. Motors.
The Bow and Trolley Types of Collector are fitted to the Car.

It does not follow that every electric-railway system will at once be converted to alternating-current practice, for it has not yet been demonstrated that the change would always be worth while. The alternating motor equipment is and is likely to remain under some disadvantage in the matter of first cost and maintenance, so that when the final balance is struck, it will be found in favour of alternating current when the element of distribution is above a certain magnitude, and the reverse when it is below that magnitude. Obviously it is not a case for hasty judgment, but for deliberate consideration. And an important feature of the matter in its bearing on the future is that a gain quite sufficient to determine the use of alternating current in a new enterprise may be insufficient to justify a radical change in an equipment already in use and which represents a large investment.

This much is certain—that alternating-current traction in some form is highly desirable for much of the future railway work; that it has already made progress enough to deserve serious consideration and to ensure future growth; and finally, that if the large experiments now under way turn out well, alternating-current motors will be pushed into very extensive use both in new work and in the re-equipment of systems in which direct-current traction has been forced beyond its economical limits. — Abstracted from Engineering Magazine.

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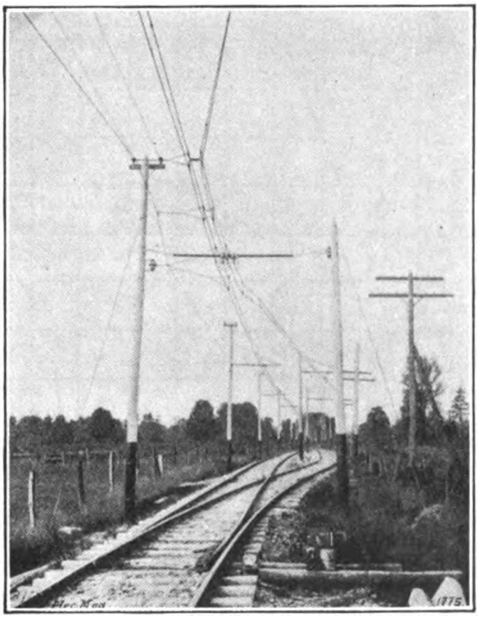
One-Phase Railway Operated by Gas Power.

The flexibility of the alternating current system is admirably testified to in an installation of plant recently put into operation on the Warren-Jamestown (Ohio) Railway. At the main station alternate current at 22,000 volts is generated and transmitted to transformer huts on a 22-mile suburban line, the pressure being lowered to 3300 volts for the overhead line, while at the terminal stations conversion to 550-volt direct-current is carried out for the town service of cars. The practice may be followed closely in the near future with suburban lines in other places, as it affords the maximum of concentration of plant, and in no way detracts from giving any desired form of supply at remote distances from the generating station.

The Warren-Jamestown system is interesting by reason of the adoption of gas engines to drive the generators, a further notable feature being the employment of natural gas, thus dispensing with producer plant of any kind. The system is located in a belt of natural cheap fuel, and proposals to utilize this for the operation of an electric railway service have been developing several years. A local car service has been run from a small plant, but only since the development of one-phase railway motors has the scheme for an interurban service fully matured. The present equipment comprises two 470b.h.p. horizontal gas engines coupled directly to 260kw. alternators, and parallel running is satisfactorily carried out without the use of spring couplings of any kind.

The trolley line is interesting in that a pressure of 3300 volts is applied to it for direct collection by the car, and, further, the transformer stations contain no moving machinery. A No. 3-0 figure 8 wire is slung by catenary suspension from a $\frac{7}{16}$ messenger cable carried on heavy porcelain insulators on angle iron brackets supported by chestnut poles. Each pole is 35ft. long and 7in. diameter at the top, and they are painted white to within 6ft. of the ground, the remainder being black. We give an illustration of a turnout of the line, and also a view of one of the cars. It will be noticed in the latter that there are two trolley wheels and one bow collector on the car roof. These have been fitted for the town and suburban lengths of line respectively. Within the boundary of the two towns a low voltage alternate-current trolley line is employed, and over this the trolley wheels are used. The two one-phase motors on each car are running in series over these lines, each motor receiving current at 250 volts. On the suburban line, which is 22 miles long, the bow collector is raised by pneumatic pressure against the overhead line, and the particular trolley wheel in service is lowered. This is done while the car is running at full speed. The trolley arms are also mounted on stout insulators, so that if the bow collector fails for any reason, the trolley wheels can be used for the high voltage service. At present only ten cars are run over the line, three interurban and seven town. Only eight employées are needed outside the general officers and car crews, made up of four car-shed men, three station attendants, and one lineman. The fuel cost of operation has been found from monthly figures to amount to 7½ cents per car-hour or about a ½-cent per kilowatt-hour. The service extends over seventeen hours per day, and no trouble has been experienced with any portion of the plant during some months of working.

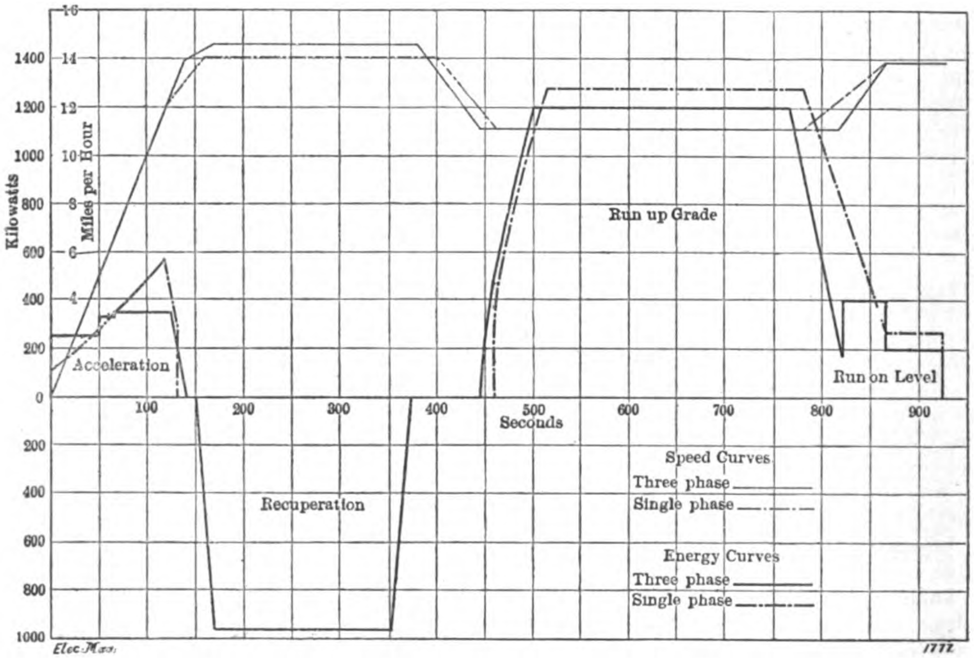


A TYPICAL TURNOUT ON A 3000 VOLT A.C. TROLLEY LINE, SHOWING CATENARY METHOD OF SUSPENSION.

The system illustrates in a striking manner how natural sources of power, when readily accessible, can be put to good use, and render reliable and economical service to a district blessed with such convenient means of obtaining and applying energy. The improvement of the gas engine and the exploitation of satisfactory one-phase railway motors have, in this particular instance, enabled the inhabitants of two towns to secure an effective local service of electric cars and a speedy and safe means of interurban transport. There must be many other spots in which similar advantage can be taken of power readily available, and merely waiting to be tapped and applied.

Three-Phase Locomotives for Tunnels.

In our last issue we gave some particulars and data of the one-phase locomotives intended to haul the trains through the St. Clair Tunnel. These had been decided upon as the best for the purpose, regarded from the point of all-round efficiency. It was almost to be expected that the champions of three-phase working would take up the cudgels in support of their particular systems. Mr. C. L. de Muralt, in the Street Railway Journal, goes closely into the operating costs, weights, speeds and installation costs of the two methods, producing evidence favouring three-phase working. The total weights when compared show 62 tons for one-phase and 50 for three, the motor weights respectively being 93,500lb. and 33,000lb., for three motors in each case. The one-phase electrical equipment totalled 30 tons and the three-phase 22 tons, while in the former case forced ventilation is employed against the natural ventilation of the latter. The speed and energy comparisons were shown by curves which are reproduced below. The respective results are clearly shown, and, according to the authority quoted, indicate a saving in favour of three-phase, even if the item of recuperation be disregarded, while in the matter of speed there is little to choose between the two systems. Comparing the cost of installation it is shown that the one-phase system calls for a plant capacity of 2500kw., while only 1600kw. would be needed for three-phase. On all counts, reckoning the special merits of each system, it is stated that out of a total capital expenditure of £100,000 a saving of £20,000 would be made by the adoption of three-phase working.



Curves comparing Energy required by Three-phase and One-phase Locomotives for Tunnel Operation (see page 102 of February issue).

On the score of energy consumption, Mr. de Muralt makes out a big balance in favour of three-phase, his figures being as follows: Total annual consumption, one-phase, 1,695,600kw. hours, at 1 cent per kilowatt = £3391 ÷ ; three-phase, 147,500kw. hours at same price = £3096, or a saving of £295 per annum. To this figure it is claimed that a sum of £953 must be added for energy recuperated during each run.

Before Mr. de Muralt's figures were published they were submitted to the consulting electrical engineer for the tunnel installation, Mr. B. J. Arnold. This gentleman, replying generally to the criticisms put forward, considered that with the complete conditions governing the case before him Mr. de Muralt would have arrived at a different conclusion. Items favouring the installation of one-phase apparatus in this case were its commercial availability and convenient access to the manufacturer supplying it. As Mr. de Muralt represents the Ganz Company, who manufacture in Buda-Pesth, this point is of importance. The recuperated energy, Mr. Arnold states, cannot be used for pumping, as was assumed, so that the main operating item saved was thereby done away with. Though in no way opposed to the three-phase system, Mr. Arnold maintained that on all points the physical conditions of the St. Clair Tunnel and the business conditions prevailing in the country merited the adoption of one-phase apparatus as authorised by him. He understood the polyphase apparatus could be bought cheaper than one-phase, but he had an instance before him of the tenders for the former exceeding those for the latter when conditions certainly favoured three-phase working.

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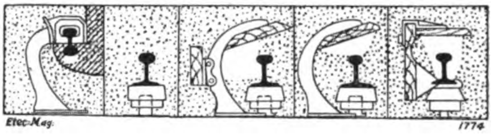
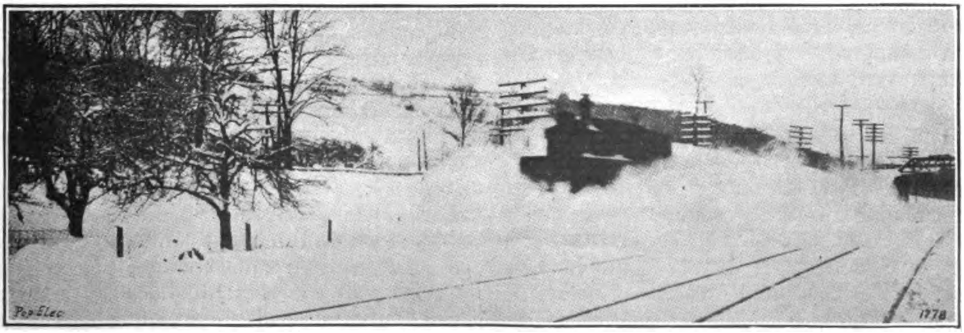
Snow and Electric Train Service.

THE employment of the third rail in open country and exposed situations, has resulted in serious dislocations of traffic during periods of severe weather. Sleet on the third rail was at one time certain to disorganize traffic, until effective steps were taken to remove it with steel scrapers. Now that third rail lines are operating and will operate on a more extensive scale over country tracks, interest attaches to tests recently made with a heavy electric locomotive through snow-covered stretches of track. The illustration on page 171 depicts the now famous New York Central direct-current locomotive after a run through about 18in. of snow. The locomotive was got out to test the effect of snow on the different types of rail employed over about six miles of electrified line. The diagram above depicts the state of the rails after the passage of the locomotive. The first test was made over the unprotected rail, which is the second from the left in the diagram, and after one or two trips the rail surface became covered with snow ironed on by the passage of the collector shoes. This set up bad sparking and the rail could not be used. The protected rails, also shown in the diagram, proved under test to be little better, as the snow flangers on the locomotive kept them covered, and ultimately bad sparking ensued. With the under-running rail, shown on the extreme left of the diagram, much better results were obtained, and after the first passage of the locomotive, the shoe effectively scooped out the snow as shown by the dark



UNDER-RUNNING AND OVER-RUNNING TYPES OF THIRD RAIL, SHOWING EFFECTS OF SNOW ON EACH.



ELECTRIC LOCOMOTIVE RUNNING THROUGH SNOWDRIFT AT HIGH SPEED.
The spreading of the snow to each side can be clearly seen.

shading in the illustration. With an over-running rail there is a tendency for the shoe to flatten the snow on the horizontal surface, but with the under-running type the shoe scrapes the surface clean each journey, and the falling snow does not heap up as it does with the over-running type. The tests clearly proved the superiority of the under-running rail, and also indicated that a new type of snow flanger was needed to throw the snow clear of the third rail.

Electric Traction Notes.

In the city of Dresden some 350 private motors, aggregating a total of 1900h.p., are connected to the mains of the tramway system and evidently give good service in spite of the inevitable voltage variations.

* *

By July 1, 1906, the freight tunnels under Chicago will deal daily with 30,000 tons of goods, representing an earning capacity of one million sterling per annum. The total cost of the Subway has been £4,000,000, of which not one dollar is Chicago capital.

* *

President E. W. Winter, of the Brooklyn Rapid Transit Co., states that his company has spent almost four million sterling on improvements since he took office in July, 1902. He says also that work now in hand will cost over two million sterling. Of the sums spent, £1,770,000 were for car equipments alone.

* *

In Rockford (Ill.) with a population of about 40,000, there are no less than sixty electric automobiles, and the number is on the increase. This patronage of electromobiles is attributed to flat country, local d.c. service, and cheap rates for charging and maintenance of batteries by local electric company.

* *

The cost of transmission conductors is a most important factor in the electrification of steam railways. It has prevented the economical adoption of the ordinary direct-current method of operation for heavy service. It is the most underlying factor in the impetus which the single-phase system is giving to heavy traction, because it employs higher voltages with greatly reduced cost of conductors.—Electric Journal.

The one-phase locomotives on the New York, New Haven and Hartford Railroad will weigh 72 tons each. The motors will develop 250h.p. each and will be of the gearless type, built up on the driving axles. The cost for 21 miles of overhead construction in steel bridges is given at £114,000 and the locomotives will cost £210,000, and these, together with a 9000h.p. power-house at £226,000, will total £550,000 for the complete electrification of 21 miles of four-track line.

* *

The Berlin-Zossen trials have supplied electrical engineers with important data on high-speed electric traction. The details may be summed up much as follows:—Keep the car body as near the rails as possible; place heavy apparatus in centre of car, and as near the ground as possible; collecting wire to be above rather than at side of car; motors to be flexibly supported on axles; the wheel base to be at least one-fifth length of car; double tracks to be wider apart than usual.

* *

During 1905 the gross receipts on the New York Subway were £1,161,185, and the operating expenses £557,754, the surplus of receipts over all other expenses being £433,914. The Elevated Division of the Interborough Rapid Transit Co. shows the following results over the six months July — December, 1905: — Gross receipts £121,953, surplus £8,372, as compared with £131,737 for the same period during 1904. The Subway has evidently made that difference to the Elevated takings, though both systems are owned by the same company.

* *

In the electric railway field it is as doubtful if it is in the long run wise to neglect opportunities to make money until the cost of labour, material, and equipment shall have decreased noticeably. Of course, the prospect of hard times and diminished traffic must always be borne in mind before saddling a proposition with a heavy burden of fixed charges; but, if a project figures out a reasonable return on the investment, upon the basis of a conservative traffic volume, it is certainly a poor plan to hang fire because the total cost of the enterprise represents high prices rather than low ones in their component items.—Street Railway Journal.

Central Station Practice

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

The Principles and Practice of Mechanical Stoking.

(Concluded from p. 108.)

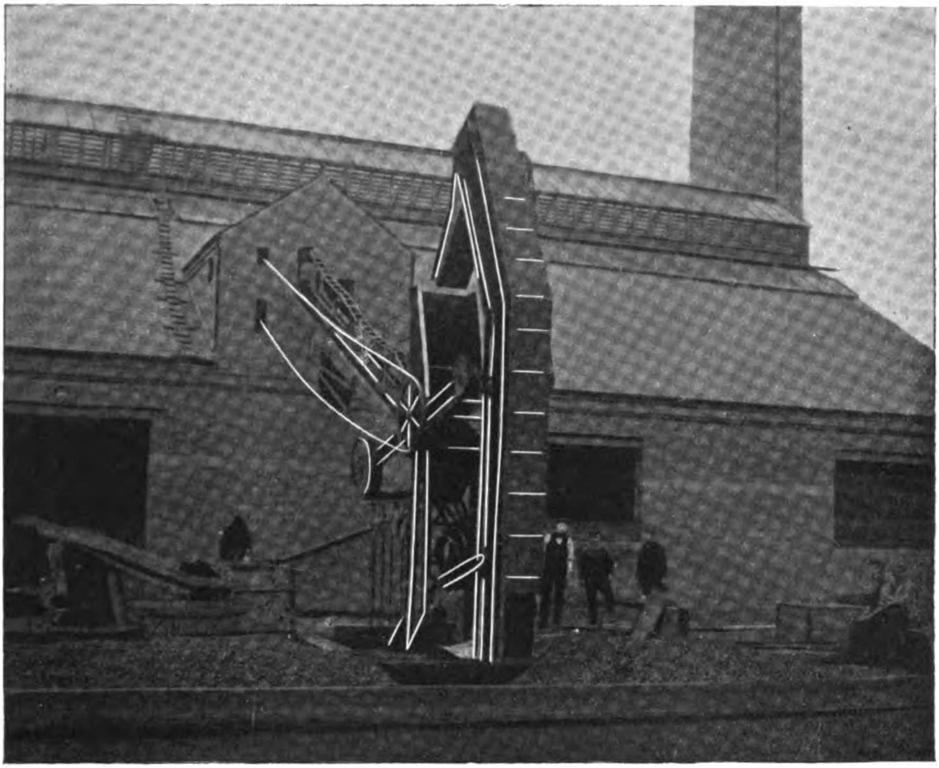
By W. H. BOOTH.

In the coking stoker the coal is pushed by plungers upon the front of the moving bars of the grate, and by them is slowly travelled towards the bridge, giving off its gases as it moves onwards, and the coked portion gradually burning away, until, at the bridge end, the bars are bare of fire, and air in large excess is leaking in through the bare grate, the air slots of which are now open and free from clinker, which is cooled and broken off, and no longer stops the inflow of air. To get over this difficulty has been a constant endeavour of stoker makers. In the Vicars machine the grate has been made so short that the fuel never burns fully out, but is rejected over the ends of the bars into a dumping pit, where the coked mass accumulates in a thick body, and is consumed by air which enters the pit by a free vertical opening accessible below the grate. As the mass burns and its lower parts are raked out as dead and cold ash and clinker, the mass descends. With the short grate the air leakage is small and the percentage of CO_2 in the furnace gas is high.

The creeping action of the grate is secured by causing all the bars to move forward simultaneously and to draw back one half or one third at once. The few returning bars cannot carry back the fuel, but when all move together the fuel must move with them. A difficulty arises when the grate must be cleaned, because when restarted after cleaning there is little or no red fuel left, and the fresh fuel which comes upon the bars burns away rapidly on its leading edge owing to the rush of the draft, and the draft cannot be seriously checked or this will cause smoke to be made. In my own practice I meet the difficulty by preventing access of air below the grate. The fuel then advances but does not burn away. It gives off its volatile gases, however, and these are burned by the air admitted at the door. The bare grate might also be hand covered to stop the enormous influx of air. Of course some of this fuel would go unburned into the dumping pit, where, however, it would burn out usefully and less waste would at least be caused than is the case when the coal pushers as now may require even hours to get the coal to the full length of the bars when the draft is very strong. This practice recognises that bituminous fuels burn under a species of divided combustion. They burn as solids in respect of about two-thirds of their mass, and as gas in respect of the other third. A grate to which air is denied access below, and above which is a highly heated brick arch, becomes simply a gas retort covered with a layer of coked or semi-coked coal which burns to some extent on the grate by reason of such air as leaks by any dampers fitted to prevent its entrance more or less completely or incompletely. As soon as the coke bed reaches the bridge, air is again admitted under the grate and the full rate of combustion of the coke is again maintained. It is not practicable to check the draft in order to moderate the rate of combustion pending the covering of the grate with fuel, because in that case there would be also a check put upon the entrance of air above the fire which is necessary to burn the hydro-carbon gases. This air is particularly necessary when the supply below the grate is shut off. To avoid grate cleaning entirely is the object of chain grates which carry in the fresh coal in a very uniform layer, the thickness of which is decided by a strickle plate or doctor plate adjustable at any desired level above the grate. As the grate moves forward the fuel gradually burns away and, the bridge end becoming bare, vast and worse than useless volumes of air enter the furnace and reduce the flue temperature and overload the flues and chimney. In a recent case the percentage of CO_2 in the flue gas was only two per cent. where one of these chain grates was in use. A damper to close the whole space under the grate from the air will not remedy matters, for the bare grate will still pass the larger proportion of such air as enters.

The air must be positively shut off from such parts of the grate as do not require it. This could be done by means of a plate directly under and touching the lower edge of the travelling chain, such plate being completely blank at the extreme end near the bridge, while towards the front end it should be entirely cut away, the parts between being perforated with a properly proportioned number and size of holes, the area of perforation dying away to nothing some distance from the bridge. This would measure the supply of air in proportion to the demand of the fuel in the grate immediately above. An American, Mr. Eckley B. Coxe, contrived an arrangement similar in its principle for controlling the air supply to anthracite coal furnaces. He placed a long open-topped box under the full length of the grate between the supporting rollers and in this long box he placed several transverse divisions. He blew air into that division next but one to the furnace front. Over this division the coal was in fullest combustion, and from this division the air could pass to each of the next fore and after compartments with considerable freedom. From the next after compartment air could only leak through a suitably proportioned orifice to the next further compartment, and so on to the end next the bridge, which would have no air intentionally supplied, though some would leak into it. Such a device obviously prevents much of the excessive flow of air which these otherwise excellent and self-clinkering grates afford. The plate which encloses the bridge end roller of these grates burns rapidly away, and it is now made hollow with a water circulation in order to preserve it. The spent ash and clinker is dumped over this flat plate into the pit beyond, whence it is raked out in the absence of a better system of removal. Where there is a cellar below, the dumping pit is best continued down to a funnel of cast iron closed by an automatic close-fitting valve door. When some amount of clinker has collected, it is automatically let out of the hopper and descends upon an ash traveller below, by which it is conveyed to the removal bin or wagon.

In that form of side-sprinkling stoker specially devised to overcome the liability to smoke, the fresh coal is sprinkled on one side of the fire only. Meantime the other side begins to burn clear. For a brief interval the sprinkling ceases and both sides become fairly clear. Sprinkling then commences on the brighter side, while the other side now begins to burn off bright. This is in imitation of the side system of hand firing and has much to recommend it. Reference has already been made to that chain grate which moves from the bridge to the deadplate end and dumps its clinker into a box in front. Apart from the fault already named, this grate has the same fault as the chain grate just described, and is subject to the same remedies which would make a success of the grate if it were not for the dust difficulty. In all that has so far been advanced it is clear that the sprinkling class of machines suffers from the almost impossibility of securing an even fire without having recourse to the levelling rake, and frequent opening of the furnace doors, which nullifies, more or less, the air regulation which ought to be possible where a furnace is worked under fairly regular conditions. The coking type of machine, however even may be its initial supply of fuel, possesses the serious fault of excess of air. The sprinkling machines are fairly perfect of their sort, and give better results than those coking machines in which the grates burn so very bare of fuel. Yet the coking principle is the better. A little consideration will lead to the conclusion that the coking type of stoker must either resemble the Vicars machine with a short grate and a large deep dumping pit behind the bridge, or some other factor must be



Typical Coal-handling Plant at Coventry Electricity Works.
The Elevator is shown lowered into the loaded barge.
(Illustration by courtesy of Ed. Bennis & Co., Ltd.)

introduced that will automatically prevent air excess.

In Great Britain stokers have been applied in the main to internally fired boilers in which the circumscribed area of the furnace prevents any great elasticity in design. The grate in such a furnace is perforce horizontal, or very nearly so. The fuel has always been conveyed along a horizontal surface, and no particle could travel faster than any other. It has been impossible to move fuel forward so as to cover the bare grate next the bridge. But in the externally fired boiler, so common in America and now widely used in Great Britain, in the shape of various water-tube boilers, the horizontal position of the grate is no longer compulsory.

If it be assumed that a fire-grate may be inclined, such an angle may be adopted as will allow the fuel on the grate to slide down to the lower end of the grate simply as an effect of gravity. If at the bottom of the inclined grate there be arranged a very short bit of horizontal grate, this will receive the slipping fuel and hold it. A mass will accumulate until the fuel on the inclined grate acts as its own support and further movement ceases.

By arranging the bottom small grate with a further grate below, and removing the upper grate, the accumulated fuel and ash on the upper grate can be let down a few inches. The upper grate is then pushed back to its place, and the clinker intercepted between the two grates is dumped to the ashpit by now withdrawing the support of the lower grate. From time to time the operation may be repeated, and on each occasion the fuel on the inclined grate will gravitate to fill the gap. The bed of fuel will thus tend to close up its own interstices, feeding down and consolidating itself as the fuel burns thin and non-supporting. In practice this action is not sufficiently regular and automatic, and practice has decided upon a less steeply inclined grate, but one in which the bars have a movement either in a longitudinal direction or as a transverse rocking. This slow movement disturbs the fuel, and, at each movement of the bars, gravity is enabled to act so as to close up the fuel bed. Various stokers of this description have been introduced in America under the name of the step grate. They have probably all come down from the original "Tenbrink" grate, common in Austria. In these grates air enters horizontally through openings at what would be called the riser of a staircase, while the fuel rests on the tread of the step. The smaller fuel cannot therefore fall through the grate. Excessive air cannot get in because the fire consolidates as it burns away, and the thickness of the fire-bed is a function of the amount of fuel fed in at the top of the grate and of the clinker permitted to accumulate on the small dump grate at the foot. Such a grate works on correct principles, and is enabled so to do simply because of its inclined position and the use made of gravitational effects, by which means alone it seems possible to move the fuel forward the more quickly as the fire becomes thinner. Much, of course, depends upon the angle of the grate, and it ought to be adjustable. Upon the nature of the fuel, its dryness, or its caking qualities, will depend the rate at which it will slip down the steps.

Sometimes the fuel will hang on the grate and the lower part will become bare. If the fuel should tend to slip too quickly, this fault will check itself because the fuel will heap up deeply at the foot of the slope, and the surface slope of the fire will become flatter and further movement will cease. In some forms of inclined grates the bars remain longitudinal with the fire, but they are unsuitable for the finer coals, which drop through the grate and are lost. Thus each case requires separate treatment, and it is clear that an adjustable slope is a valuable feature.

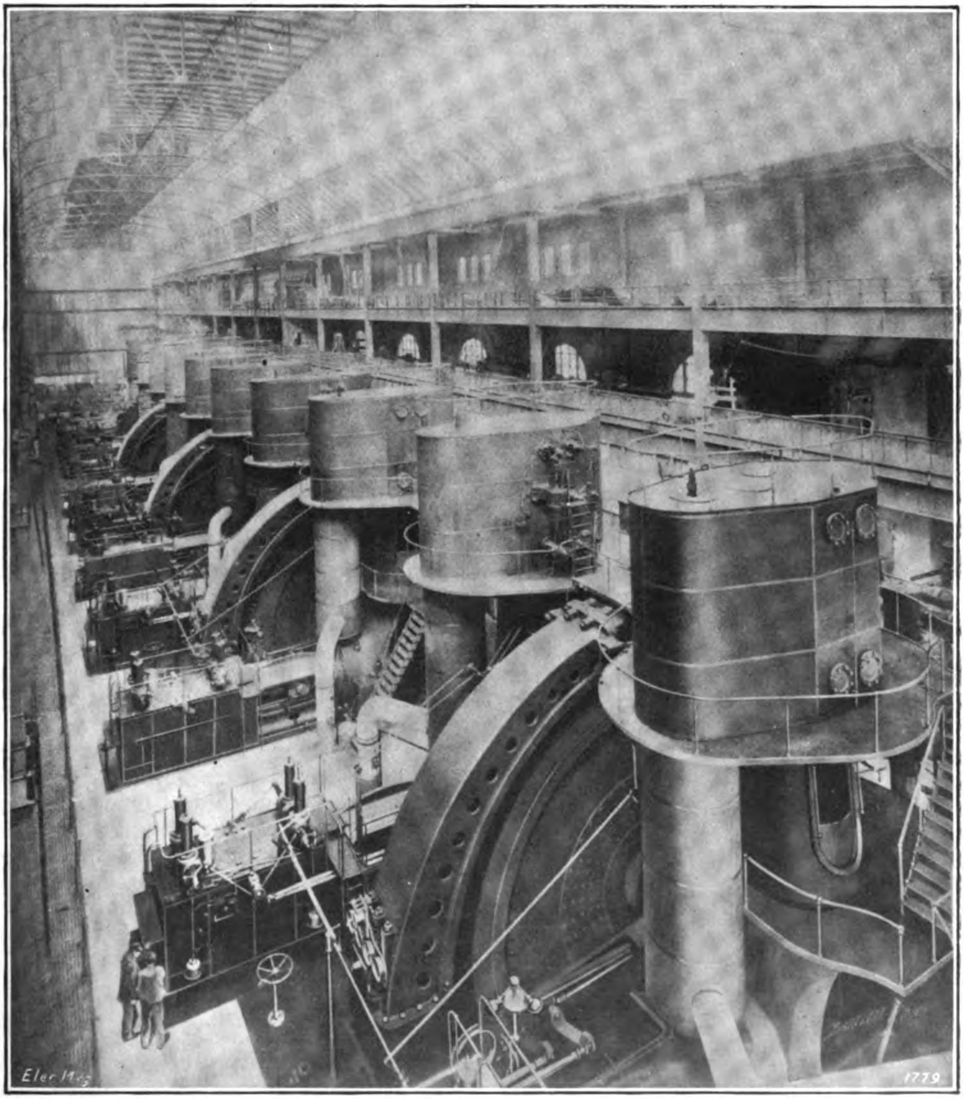
Mechanical stoking is only an aid to smoke prevention in so far as it enables the feeding of a furnace to be performed with regularity. Many stoking machines gain a good character as smoke-preventers simply because, instead of producing short bursts of black smoke, as happens with some hand firing, they pour out a regular stream of smoke all the time, which aggregates to a daily total in excess of the total of the brief outbursts, but at no time presents such a dark appearance as to lead to trouble.

If mechanical stoking is to be at once smokeless and economical, the same care in furnace construction is necessary as with hand-fired work. There must be air sufficient without excess, thorough mixture of the air and gases, and a sufficient conservation of temperature to enable combustion to be completed, or well advanced, before too much heat is allowed to be absorbed by the boiler. This of course demands furnaces more or less perfectly lined with refractory substance—firebricks. It demands a sufficient run for the gases to allow them to mix and burn with the air. It is to get this long run that I prefer to admit air at the door through grids rather than at the bridge.

Experience proves that in internally fired boilers the presence of water pipes, placed across the tubes beyond the furnace, is productive of smoke. It also teaches that the worst boilers for smoke are those which allow the gases from the grate to rise directly from the grate and pass among the cold water tubes. All experience points the same way, and emphasises the importance of air mixture and temperature, and points out that the longest run in a refractory flue or combustion chamber will permit of perfect combustion with the least excess of air. The minimum of air can next only be secured where there are means of consolidating the fire by some gravity effect. Temperature can only be conserved by the use of refractory furnace linings sufficiently extended along the run of the gases. It must be remembered that whereas a coal may burn with a smoky flame of great length when insufficiently hot, it may burn with quite a short flame under other conditions. The provision of good conditions has in fact a cumulative effect.

There are no reasons at all for producing smoke from bituminous fuels, except neglect of the correct principles long known to be necessary. These must be observed with mechanical stoking equally with hand stoking. There is no virtue whatever in the word mechanical, and mechanical aid cannot effect anything special. It can, however, reduce an arduous manual toil, and it can make easier certain other things, such as the prevention of excess air entering at doors. At the same time it easily introduces the very faults it is intended to avoid, and must be applied with caution and intelligence.

It has been remarked in this country that outside the hard-coal areas of the United States the problem o bituminous coal combustion has been attacked on sounder lines



THE STEAM GENERATORS SUPPLYING THE NEW YORK SUBWAY WITH POWER.
The horizontal-vertical Engines are by Allis Chalmers.

than have been adopted here. The Dutch oven furnace is hardly known here. Indeed, the wide prevalence of internally fired boilers of the Lancashire type has militated against the Dutch oven or refractory lined furnace, for the furnace of the Lancashire boiler is quite correct in three of the four essentials of smokeless combustion. These are: (1) A furnace so arranged as to allow fresh air to be admitted over the fire to mix with the gas, and the whole to sweep over the length of the fire towards a bridge; (2) A draft sufficient to admit such necessary air; and (3) A space free from obstruction in which combustion may complete itself. The fourth necessity is a sufficient temperature to be conserved before abstracting heat from the incompletely burned gases. The water-cooled furnace of the Lancashire and similar boilers often fails to enable this last point to be secured. It is fairly secured in the Dutch oven furnace, which also secures the first three requisites named. To set some water-tube boilers so as to be smokeless may cost something more than to set them in the ordinary manner usual with hard coal, *i.e.*, so that the furnace gases rise vertically up among cold tubes. Engineers seem to look so little to working costs and so much to mere first cost that they will incur years of increased running cost and numberless fines for smoke rather than face the small extra cost of a good setting. The very usual result of this parsimonious policy is that eventually expensive Welsh coal of so-called smokeless quality has to take the place of the cheaper bituminous fuel. This all rises from a persistent refusal to look the facts of combustion in the face. College-bred men are not a bit better than those who have graduated on the shovel. Mechanical stoking cannot prevent smoke if other essentials are absent. Some engineers put in mechanical stokers hoping to secure smokelessness from their action, and when the machine fails to subvert the laws of chemistry they blame the machine instead of themselves. As with all other machinery the stoker requires to be installed with intelligence and used in the same way. The object of all stoking is to manufacture the maximum of CO_2 at a maximum temperature. Properly thought out this aim, if successful, will secure economy.

Advertising Follow-Up Methods for Central Stations.

By FRANK B. RAE, JUNR.

A FOLLOW-UP system is built upon the same principle as a bulldog. It is founded on the never-let-go theory which presupposes the recipient of the follow-up matter to be a prospective customer who in time may be persuaded, argued, enticed, or hectored into buying. The system is designed to place selling arguments before the prospective buyer from twelve to fifty times a year. This cannot be done by a solicitor except at prohibitive expense. It can be accomplished successfully by following-up for from half a dollar to two dollars per prospect per year.

The follow-up advocate takes it as granted before he puts his system into play that each prospect is "alive," and that in order to bring him into line it is necessary to :

(a) Supply complete information touching the product for sale, its uses, advantages and superiority.

(b) Appeal to the thriftiness and home pride.

(c) Overcome prejudices, just or unjust, which may exist against the advertiser.

(d) After the prospect is otherwise won, overcome the common failing of procrastination and close the sale.

He does this by a series of direct-by-mail advertisements which aim to touch successively each cord until the prospect surrenders. Theoretically he perseveres till the prospect buys or dies.

Follow-up methods are as various as the men who design them, but it is safe to assert that, in the case of central stations, no such scheme will be successful which does not embrace the co-operation of well-drilled solicitors and friendly newspapers; or which is not well and carefully planned and systematized in advance of the first mailing. A disjointed succession of diversified mail-cards, folders, and letters does not constitute a follow-up system. It cannot be counted upon to give consistent dependable results. At best it is but a hodge-podge issued hurriedly and at random, or, when other business is pressing, not issued at all.

As a preliminary to any aggressive follow-up campaign for business, the newspapers should be cultivated. They should be supplied with non-technical news items on electrical subjects of interest to their readers; with information on which to make announcements of improvements in the local plant, any reduction in rates, extension of lines, or other improvement, and requested to add comment, pointing out that the company is voluntarily and aggressively bettering its service. This may look like a long order to some lighting companies, but it is worth all it costs, especially now when the public is being lashed to a fury against utilities corporations, the "money power" and the "trusts." The purpose of favourable newspaper comment is to prepare the way for favourable or, at the worst, neutral reception of the follow-up matter; for without such neutral reception your advertising will have the double duty of first overcoming whatever prejudice may exist against the company, and then persuading the public to get on circuit.

The actual follow-up matter should be planned, prepared, and systematized with very strict regard to local conditions, the attitude of press and public, and the class or classes of people who are being solicited. It is in the planning and systematizing that such a campaign wins or loses—in the logical sequence of the advertising used; in the careful manner in which inquiries are to be acknowledged and followed, and in strict adherence to both the condition and the policy of the company. All the various mailing cards, letters, and folders should be written and designed in advance. The system of handling enquiries, of checking and revising the mailing lists, of adapting the solicitors' labour and reports to the mutual benefit of both solicitors and the advertising—these are all vitally important points to be settled before a single piece of matter is issued. Having settled them the actual follow-up work resolves itself into the very simple proposition of seeing that the matter goes out promptly on the scheduled dates, that enquiries are carefully checked, followed, and reported upon, and that the enthusiasm of the soliciting force is kept at red heat.

When it is understood that the chief object of the follow-up is to pave the way, introduce and make definite appointments for the solicitors, the importance of having the latter always enthusiastic, always agressive, will be appreciated. To be sure, the advertising will bring many voluntary contracts to the office, but the campaign should be educational rather than importunate; it should be tactfully insistent in presenting the advantages of central station service, rather than bluffly demanding business. The actual business-getting must, and always will, remain with the soliciting force. Advertising was never intended for, and never successful in, actually making sales except in the case of "mail order" propositions.

The follow-up method, so far as the central station is concerned, is merely an advertising plan whereby you regularly, persistently and effectively keep the advantages of your service before every prospective customer within reach of your mains. That good follow-up is good and that poor follow-up is bad, has already been shown by the experience of several well-known lighting companies. That the method can be adopted with profitable results by the smaller plants has also been demonstrated. Invariably when the scheme has failed to give the expected returns, the failure has been in the early planning. It may be made too elaborate, or too voluminous. It may contain too much bull-dozing. It may be wasted upon ill-chosen lists. Most serious of all, it may be designed by an advertising man ignorant of the ethics of the lighting business, or by a lighting man lacking in advertising genius and experience.

Such faults should not be charged to the method, but to lack of skill in installing it. For in the last analysis, follow-up means simply organized advertising as opposed to a hit-or-miss lack of method in advertising, and as such is adaptable to any station where there are a hundred prospective customers.—Electrical World.

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The Value of Condensing.

Engineers are not all agreed on the subject of condensing plants, though the use of condensers of some pattern is now practically standard in electricity works. The subject of the efficiency and design of surface condensers was recently treated by Mr. R. W. Allen in a valuable paper published in the proceedings of the Institution of Civil Engineers.

The discussion was productive of much useful information, and was contributed to by many prominent engineers. Mr. W. H. Allen included in his remarks a useful table comparing the capital costs of non-condensing and condensing plants, and also giving figures of the operation of each. Below 150kw. he considered independent condensing questionable on grounds of cost. Dr. T. E. Stanton attached great importance to the velocity of the circulating water through the condenser tubes and pointed out that from his own experiments an appreciable improvement of the vacuum was noticeable with increased velocity. He considered the ideal condenser as one having very short vertical tubes, as personal experiment with such a condenser had demonstrated its efficiency. Mr. W. J. Harding referred among other things to the subject of corrosion, and considered that corrosion of the iron barrel should not be prevented, as it proved the salvation of the tubes. Hot feed water he regarded as a mistake, because the hot water held the lubricating oil in solution and prevented its retention by the oil separators. The colder the condensers were run the less oil went into the boilers. A dispersing plate at the mouth of the exhaust pipe he considered necessary to prevent steam panting into the condenser and causing vibration of the tubes. Regarding air pumps the secret of their successful operation depended more on valves than plungers or pistons in the pump.

COMPARATIVE COSTS OF CONDENSING AND NON-CONDENSING PLANTS.
(BOTH OF 1000KW.)

CONDENSING.	£
Engine and dynamo, 21lb. of steam per kilowatt-hour ...	5275
Boilers (3), 22,000lb. per hour...	1650
Feed-heater, 2200lb. per hour (for make-up feed) ..	50
Feed-pumps, 22,000lb. per hour ...	75
Pipework ...	250
Foundations ...	200
Chimney ...	500
Surface-condensing plant 22,000lb. per hour, 25in. vacuum; temperature of circulating water, 80° F.; efficiency of dynamo, say, 93 per cent. ...	955
Cooling-tower with foundations ...	700
Oil-separator ...	180
	£9835
WATER—	£
Make-up for cooling-tower 1600gals. per hour, 280 days of 10 hours, 9d. per 1000gals. ...	168
Make-up feed 220gals. per hour, 280 days of 10 hours, 9d. per 1000gals....	23
Evaporative duty, 9lb. of water per pound of coal.	
COAL—	
1.09 ton per hour, 280 days of 10 hours, 20s. per ton ...	3050
Coal per kilowatt-hour 2.45lb. Coal per B.H.P. hour 1.7lb.	
Labour (3 men) ...	150
Interest and depreciation, 12½ per cent. on £9835...	1230
	£4621
Balance ...	1279
	£5900

£1279 = 21.6 per cent. saving on £5900 in favour of condensing.

NON-CONDENSING.	£
Engine and dynamo (27.5lb. of steam per kilowatt-hour) ...	5475
Boilers (4), 27,500lb. per hour...	2199
Feed-heater, 27,500lb. per hour ...	250
Feed-pumps, 27,500lb. per hour ...	90
Pipework ...	150
Foundations ...	250
Chimney ...	600
	£9014
WATER—	£
2800 + 10 per cent. loss = 3080gals. per hour, 280 days of 10 hours, 9d. per 1000gals. ...	322
COAL—	
1.52 ton per hour, 280 days of 10 hours, 20s. per ton ...	4250
Coal per kilowatt-hour 3.4lb. Coal per B.H.P. hour 2.36lb.	
Labour (4 men) ...	200
Interest and depreciation, 12½ per cent. on £9014 ...	1128
	£5900

German Central Stations.

THE Elektrotechnische Zeitschrift recently devoted considerable space to the yearly statistics of German central stations, comprising a vast amount of information current up to April, 1904. Only those plants are included which sell current to consumers or supply public lighting. There were 51 plants having a capacity of more than 2000kw. in 1904. The three largest are in Berlin, and their representative outputs are 85,136, 30,000, and 25,895kw. The total capacity of the 51 stations of more than 2000kw. is 296,693kw., the stations being in 33 cities. The development of central stations and their connections in Germany in general is shown in the following table:—

	1894.	1900.	1904.
No. of stations ...	148	652	1,028
No. of 50-watt incandescent lamps connected ...	493,801	2,623,893	5,687,382
No of 10-ampere arc lamps connected ...	12,357	50,070	110,856
H.P. of motors (not including traction) ...	5,635	106,368	263,036

In recent years several plants have been erected which supply current to a number of cities and towns in a district; thus the Bruehl central station supplies current for lighting and power to 66 towns at a distance of from 9 to 12 miles from the station. On the other hand, there are some small plants which supply current for power purposes to houses for the support of house industries. A typical example is the Anrath plant near Crefeld. All the motors connected to the mains are in this case between ¼ and ½h.p., and are used in the silk industry. In recent years the use of power has enormously increased, as is shown in the following table of comparison between the kw. used for lighting and for power:—

	Kw. for lighting.	Kw. for power (not traction).	No. of motors.
1885 ...	250	—	—
1890 ...	3,899	112	28
1895 ...	10,752	2,252	663
1900 ...	21,122	22,037	5,764
1904 ...	36,195	44,448	12,933

There is only one plant in Germany which buys energy in bulk from a larger works and sells it in retail to consumers: this is the Spandau station, which gets the current from one of the large Berlin works.

LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Illuminating Engineering.

In our November issue we raised the cry for the illuminating engineer, the man whose word on the disposition of lamps should be law, and from back of whose experience advice could be brought to bear on a subject sadly lacking the elements of professionalism. We are delighted to report that a Society of Illuminating Engineering has now been formed (it is in New York, but that does not matter), and the membership list is on the way to the century mark fast. The officials anticipate a membership roll of five hundred before many months are past. At the first regular meeting the President, Mr. L. B. Marks, delivered his inaugural address, in the course of which he outlined the objects of the society and justified its existence in the following terms: "Broadly speaking, the electrical engineer has concerned himself with improving the efficiency of the generating apparatus and cutting down losses in the transmission of power; but when his wires reach the point at which the electricity is to be transformed into light his engineering skill has not, as a rule, been applied. Similarly the gas engineer has been busy with questions involved in the manufacture and distribution of gas, while the problem of obtaining the maximum value or most effective use of the illumination delivered at the burners has been relegated to a secondary position. So far as interior illumination is concerned, the lighting lay-out has been left largely to the architect. It is he who usually prescribes the number and location of outlets for the light sources, specifies the number and candle-power of the lamps, and designs or selects the lighting fixtures and accessories. The natural tendency of the architect is to make the economical side of illumination subservient to the æsthetic, while on the other hand the tendency of the engineer is to consider only the question of economy." Mr. Marks laid particular stress on the effects of artificial illumination on the eyesight, and attributed much of the undue strain to faulty location of light sources. He also gave some remarkable figures regarding the money annually spent on artificial lighting in the United States. He gave the following approximate figures:—

Electric light, between £20,000,000 and £24,000,000.
Coal and water-gas, between £7,000,000 and £8,000,000.
Natural gas, £340,000.
Acetylene gas, between £500,000 and £600,000.
Oil, £12,000,000.

These figures may be roughly aggregated at £40,000,000 a year for lighting purposes, and Mr. Marks considered that at least £4,000,000 of this is absolutely wasted from the point of useful illumination. Concluding his remarks, the President appropriately summed up as follows: "In the Illuminating Engineering Society the electrical engineer, the gas engineer, the architect, the fixture maker, and the decorator will meet on common ground. By such specialization the advancement of the art can best be furthered. To adequately cover the ground and keep abreast of the times a society devoted to the advancement of the science and art of illumination must meet frequently. The society is thus in no sense antagonistic to other organizations having to do with lighting. On the contrary it aims to co-operate with such organizations to advance the interests of all concerned."

We now want to be in a position to report on the first meeting of a British Illuminating Engineering Society, because one is badly needed.

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Reflectors, Globes, and Shades.

We are now able to continue our references to the data compiled and published by Messrs Cravath and Lansingh in the Electrical World, and dealt with in part in our January issue.

The shades common to offices were specially treated by the authors, and a good example is that shown in Fig. 1, which depicts the light distribution from an aluminium coned reflector with frosted finish inside. In dealing with a common form of opaque coned shade it is pointed out that with a plain bulb and the bright reflecting surface a streaked light is produced which proves very annoying where the lamp is subject to swing or any slight movement. The curves of light distribution from the aluminium reflector are self-explanatory, and the marked improvement in the light will also be noticed. The type of shade is extremely light and has considerable vogue for portable lamps or swivel bracket lights. It is not easily broken, which is a strong feature in its favour.

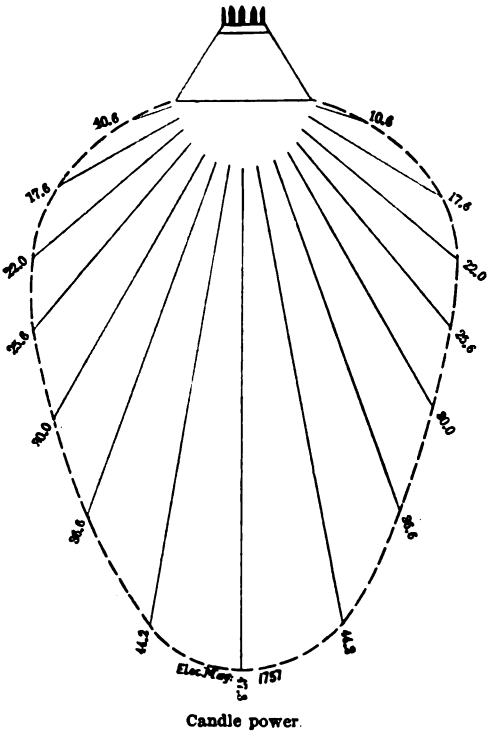


Fig. 1. Distribution from an Ordinary Coned Reflector.

There are on the market shades with mirror reflecting surfaces from which very powerful illumination is obtainable. These shades have the disadvantage of losing their reflecting power, owing to the deterioration of the mirrors. As an illustration of the illumination produced Fig. 2 is an excellent example, the shade being known as the M'Creary. It has a silvered mirror reflecting surface, but the mouth of the cone is closed by a ground glass bottom which diffuses the light and eliminates streaks. The construction of the shade will be clearly seen from the illustration adjoining the light distribution chart.

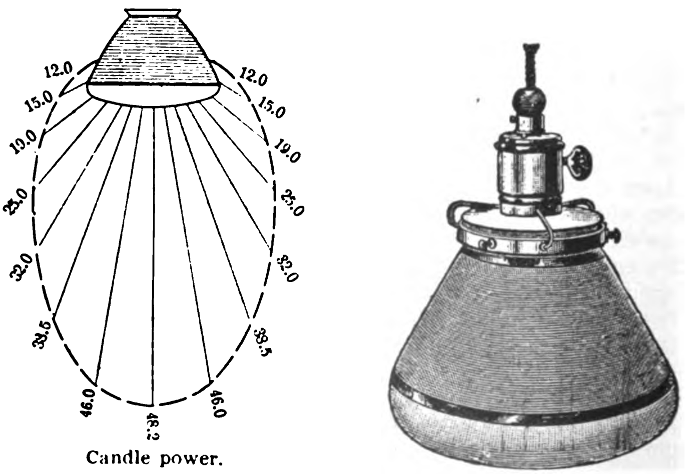


Fig. 2. McCreary Shade and Light Distribution from it.

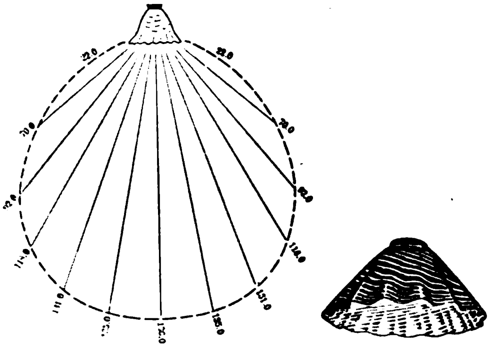


Fig. 3. X Ray pattern Reflector and Light Distribution Chart.

The result is similar to the aluminium coned reflector, but this shade has the advantage in that the lamp is not rendered visible, no matter at what angle it may be held. It is, of course, essential with closed shades of this kind hanging vertically down that they be kept dust tight, otherwise the light falls off very rapidly. Another special form of mirror reflector known as the X ray employs silvered surfaces to increase the distribution of the light. A series of corrugations is given to the shade with the idea of removing the scintillation. Fig. 3 shows the shade itself and the distribution of light from it. It has very great concentrating power, and is strongly recommended for shop windows, office desks, and billiard tables, or in any position where an opaque reflector is not objectionable. It is more costly and subject to damage than an aluminium reflector, but it has good features in the more powerful light and the ease with which the surfaces can be cleaned.

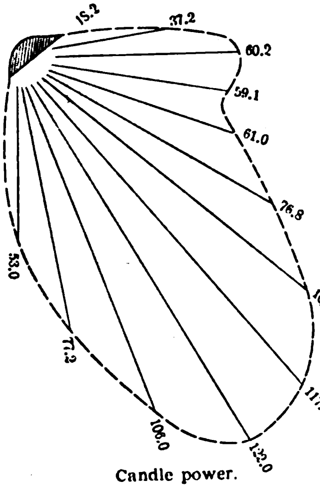


Fig. 4. The Effective Distribution from a Trough Reflector for Shop Window Lighting.

Trough reflectors are widely used nowadays, in fact there are systems of lighting employing them for which great things are claimed. The results of tests shown in Fig. 4 go to show that such a form of reflector is of great value, and when glass mirrors are used, as was the case with sample treated, the improvement in concentration bears out the contention that for shop windows and show cases such a reflector is greatly to be desired.

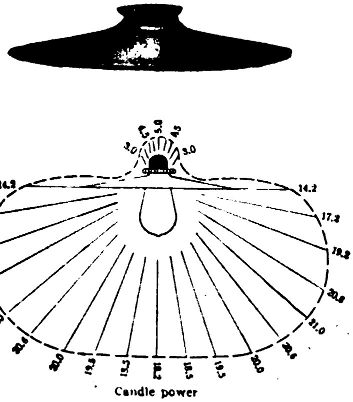


Fig. 5. A Special Dished Reflector and the Effective Distribution from it.

Fig. 5 depicts a flat opal reflector, and the kind of light distribution to be expected from it. Here it will be noticed that the light is thrown down well, and also it is well distributed in a horizontal plane, though there is little or no light above the horizontal.

A shade of this pattern is useful to light somewhat dimly a large area from one lamp without concentrating much light below the lamp. It is especially suitable for low rather than high ceilings, and is useful therefore in basements. It has the disadvantage of leaving the light unshaded, so that it is advisable to employ frosted lamps to diffuse the glare and obviate the streaked light from the bare filament.

A New Metal Filament Lamp.

In the issue of February 4 of the *Elektrotechnik und Maschinenbau*, the organ of the Vienna Electrical Society, Mr. Joh. Kremenezky, of Vienna, gives some results obtained in his factory with a new metallic filament lamp for which patents have been applied for by Dr. Hans Kuzel, of Baden, near Vienna.

So far more than a hundred lamps have been tested, and the first tests in the factory showed an average power consumption of one watt per hefner candle (.88 British candle) with a useful life of at least one thousand hours, the average decrease of candle-power being not more than 15 per cent. of the original value. These results were obtained with a testing current not furnished from a storage battery, but from the ordinary supply mains. Later tests have shown steadily improving results, and the following table refers to a 19-volt lamp:

Hours.	Hefners.	Amperes.	Watts per c.p.	Difference in c.p. in per cent.
0	29.0	1.48	0.97	0
503	28.8	1.48	1.02	— 0.7
1110	26.2	1.49	1.08	— 9.7
1686	25.2	1.48	1.11	—13.1

After 1686 hours the voltage was raised to see how much increase of voltage the lamp would stand. At 60 volts the filament was disrupted, but spontaneously "soldered itself" and the lamp continued to burn. The behaviour of a lamp with increased voltage is indicated by the following test of a normal 20.2-volt, 19.5-c.p., 0-87-amp. lamp consuming one watt per candle-power.

Volts.	Hefners.	Amperes.	Watts per c.p.
20.2	19.5	0.97	1.00
25.8	50.0	1.14	0.588
32.7	100.0	1.30	0.425
34.5	125.0	1.31	0.370
39.0	180.0	1.44	0.312
40.6	211.0	1.475	0.283

The development of the lamp has not yet reached finality, and the consumption of power may be reduced to one-half watt per hefner candle-power, with a useful life of 1000 to 1500 hours. The new lamps will be made for voltages up to 110. "The cost of manufacture of the lamp will be comparatively small, since the raw materials required for its manufacture are available in unlimited quantities and are inexpensive." The author expects to place the lamp on the market before the next season begins. Nothing is said concerning the nature of the filament. As a reason for this reticence it is stated that the patents are still pending. It is probable that the lamp is the new tungsten-filament lamp, about which some vague reports have recently been published.

Lighting and Heating Notes.

The City of London Electric Lighting Co. is not taking gas competition for street lighting lying down. It now offers the City Corporation to conduct a demonstration of the most modern system of street lighting, free of all cost to that august body.

* *

Modern flame arc lamps can be burned two in series on 110-125 volts, and four in series on 220-240 volts. Their mean hemispherical candle-power is 1560, and energy consumption 0.265 watt per mean spherical candle. The maximum of burning hours in special lamps is fifty hours.

* *

The New York Edison Co. recently tendered for the street lighting of Manhattan and Bronx boroughs at £16 per 450-watt arc per annum. There are 5000 lamps in the districts mentioned, but in Philadelphia there are 10,297 street arcs for a million of population.

* *

Despite the great increase of electricity works in Germany the returns of gas companies show an increase in the consumption of that commodity. With electrical energy the tendency to develop has been rather in the direction of power service than lighting supply. Nernst and osmium lamps are very widely used, and are stated to give complete satisfaction.

* *

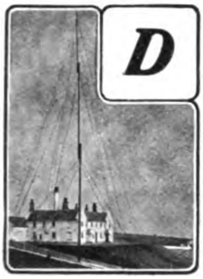
Tantalum, the metal of which the new lamps are made, is extremely ductile and becomes very hard after hammering. An ingot of the metal beaten out to a millimetre thick was drilled with a diamond drill making 5000 r.p.m. for seventy-two hours continuously, after which a depression of half a millimetre was found and the diamond was much worn.

TELEGRAPHY & TELEPHONY

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Transmitting Distance in Wireless Telegraphy.

By Capt. L. D. WILDMAN, U.S.A., Signal Corps, U.S. Army.



DR. J. Erskine-Murray, in the course of a lecture on the recent advance in wireless telegraphy, has attempted to deduce a formula for indicating the limit of distance in transmission.

After deducing the equation

$$C = M\left(\frac{k}{\sin\theta} - 7\theta\right)$$

where C = received current,
M = minimum current that will actuate receiver,
θ = angle subtended at centre of earth by arcs over which transmission is taking place,
k = a constant,

he quotes Duddell's and Taylor's experimental results, and ends by saying that this formula is doubtless very rough, and in many parts incomplete.

Many different formulæ have been presented by different experimenters, but none of them appears to be of much value in designing a wireless plant to transmit a given distance. It is probably impossible to introduce into any formula the amount of absorption in the electromagnetic wave, by its propagation over any terrain where there exist natural objects. In other words, it is probable that no formula can be devised at present for wireless telegraphy over land. We must, therefore, confine Dr. Murray's formula to transmission over water, and probably over salt water.

From experiments conducted in Alaska, between the army stations at Fort St. Michaels and Safety Harbour, the present writer is of the opinion that Dr. Murray has left out one very important factor, which seems to have been generally neglected by everyone who has written upon the subject of wireless telegraphy. That factor is the absorption of energy from the aerial wire at the sending end, due to particles of water vapour, ice, or snow driven against it (while charged to a high potential) by winds.

The experiments covered an entire year, during which were charted all of the atmospheric variables which appeared to have any effect upon this phase of the question, with the single exception of the percentage of moisture suspended in the air. This exception is an extremely important one, but during the major portion of the time in Alaska, the temperature was below 32°, no instruments by which the amount of percentage of moisture, ice, or snow could be determined was available.

The chart (shown in Fig. 1) covers a period of about a month, from October 20th to November 14th, and it will be seen that the strength of the signals received decreased with the velocity of the wind to a very marked degree. The device used for determining the strength of the signals was very simple, but is believed to have been fairly accurate. It consisted of a variable resistance, placed across telephone cords, as shown in Fig. 2.

By reducing the resistance when signals were being received, the strength of these signals could be cut down to a point where they were just intelligible. The amount of this resistance varied on different days, and

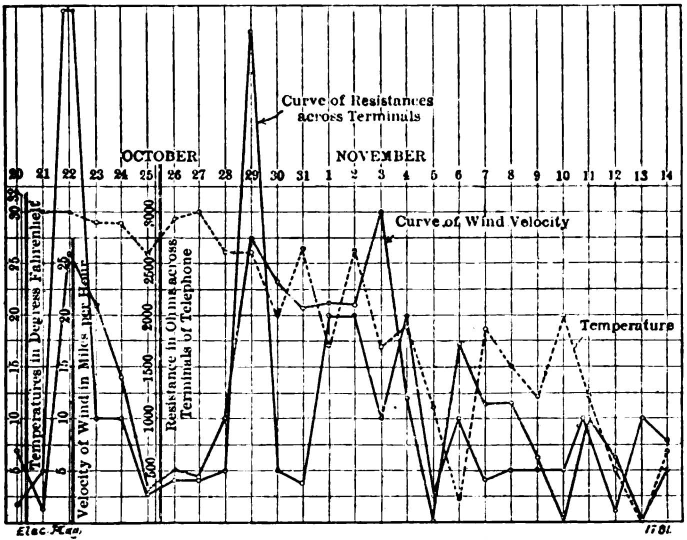


Fig. 1. Chart showing Effects of Wind Velocity on Aerial Wire.

by recording the resistance a comparative record was thereby obtained. For instance, on the 21st October there was little or no wind, the temperature of the air was just below freezing, and signals could be heard with a resistance of only 400 ohms across the receiver cords. On the next day the velocity of the wind was thirty miles an hour, the temperature was about the same as that of the previous day, but the signals could not be distinguished with less than 8000 ohms across the cords. This day was an exceptional one, in that the air was full of driving snow. Similar occurrences show all the way through in a fairly constant manner, and the record for 365 days seems almost conclusive proof that the factor of moisture and wind velocity must be taken into account in any formula. The instruments used in these tests were very crude, as it was not originally intended to carry on this experimental work in Alaska. The moisture had to be judged without instruments, but the anemometer used was reliable.

The electrical constants of the sending mechanism were recorded at both stations, but these were so uniform that they have been left off the chart. It was impossible to make these experiments at both stations at the same time, for the instruments were sufficient for one only. The effect, therefore, upon the receiving antenna, as well as upon the sending antenna, is as yet an unknown quantity, and there is much room for experiment upon this subject.

Concerning the method of obtaining the relative strength of signals, the writer (in the columns of the Electrical World) is also quite well aware that the method used is somewhat crude, for the operator's hearing is probably less acute on some days than upon others, and he was also bothered by the fact that the operating room had no doors between it and the rooms where the squad lived. The operator could also hear the land line telegraph sounder, and in the next room was the 6h.p. gasoline engine used to drive the generator. The building was also of poor construction for that climate, and had a corrugated iron roof which made much noise during high winds.

The results, however, show such uniform fluctuation between the signals and the wind velocity that there seems to be no room for doubt concerning the general effect. One important change was made on account of these experiments. The poles for the aerial in Alaska were planned and erected with an idea that 50 or 100 wires would be suspended

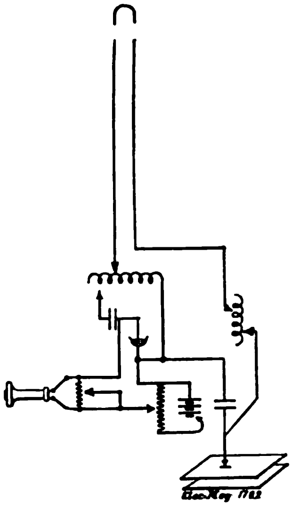


Fig. 2. Diagram of Apparatus Experimented with.

from the cross stay for the purpose of getting a large capacity for radiation. The aerial was, however, cut down to a small grid about 10ft. in height, with but two wires connecting it with the sending apparatus. For, if it is correct that the energy of the aerial is lessened by the number of particles charged by it (and carried away) the effectiveness of the aerial is decreased in direct proportion to the number of wires in the aerial.

The mechanical difficulties with a two-wire aerial are very much less than those connected with a 50- or 100-wire aerial, particularly in regions where there are, at times, wind velocities of ninety miles an hour, and where the aerial may be thickly coated with ice and frost. Referring again to Dr. Murray's formula, it is believed that in designing any two stations the maximum factor of dissipation of energy due to wind velocity and particles of moisture, ice, or snow must be taken into account when determining the value of C.

❧

Telephone Troubles.

One of the most common cases where an exchange is operated upon a common return or grounded basis consists in the common return wire being connected to the wrong side of the line, *i.e.*, the common return or ground wire will be connected to both the tip and sleeve wires of different line jacks. Say line No. 1 has the tip wire connected to ground, and then line No. 2 the sleeve wire to ground, and so on throughout the entire switchboard. What makes this case of line reversal very mysterious to some people, is the fact that they can connect together certain lines and obtain good service, but they do not know that when, say, line No. 1 and No. 2 are connected together that both subscriber No. 1 and No. 2 are "talking into the earth," so to speak, for the sleeve wire of line No. 1 has been connected to the sleeve side of the cord circuit through to the sleeve side of line No. 2, and thus led line No. 1 directly into the common return, or earth, the same being true of line No. 2. In other words, the result of this reversal is all the more mystifying because sometimes line No. 1 works fine because it is connected to a line in the board which happens to have the same side of the spring jack grounded. Of course, when such cases come up, it is easy to straighten out the difficulty when you get at the nature of the complaint. It is sufficient, as a rule, for the trouble correspondent to learn that the switchboard trouble is of a character in which some lines can be connected with other lines and work fine, while at other times the circuit will not work at all.

This matter of line reversal is not always the only instance where certain lines cannot be connected together and the same lines can be connected with other lines and give good service. This refers to cord reversal. When a switchboard has been installed, and it becomes necessary to rebutt cords, then the man who has not had the same "case" before is quite likely to connect the tip of the answering cord to the sleeve circuit of the calling cord, with the result that when this particular cord circuit is used, then the lines which are connected together through it are "dead." And when we add to this the fact that certain lines in the switchboard are operated upon the metallic plan, while the remaining lines operate either common return or ground or grounded, then it is easy to find a reasonable excuse for the switchboard man's statement that there is something wrong with the switchboard, for when lines are connected together, sometimes they will work and sometimes they will not work.

One of the most discouraging communications a manufacturing company frequently receives (and usually from customers 500 or more miles away) runs about as follows:

Telegram.—"Send man at once. Board gone dead."

Now there may be a dozen different cases of trouble which call for this form of communication. A receiver cord may be broken, a transmitter cord may be broken, there may have been a failure in properly connecting the common return wires, or it may be a case similar to one experienced not many years ago, but happily no longer very common, where, when the expert arrived, he found that the batteries intended for the transmitter supply circuit had been connected to the generator terminals of the keys and thus prevented any possibility of ringing out over the line, and in an endeavour to fix up the trouble, the batteries intended for the night alarm circuit had been connected to the operator's selector terminals. Of course, the board certainly was "dead," excepting that the subscribers could ring the drops down. The lineman who installed the board had done as well as he knew how. His lines were properly connected and he proved there was battery somewhere, for when he opened and closed the battery wire connecting to the operator's selector circuit, or worked the listening key, he heard a click, and while he did not understand what to do with "those two terminals" connected to the wires coming from the transmitter, he had every reason in the world for calling in the manufacturing company's expert, who, it is needless to say, quickly brought the board "to life."

The foregoing experience is a case which actually happened, and simply shows that such things must be experienced before one thoroughly appreciates the difficulties of handling telephone troubles from a distance by correspondence, and gives such advice as may permit of the difficulty being straightened out without sending an expert hundreds of miles to straighten out a simple case of trouble.—H. P. Clausen in Sound Waves.

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Telephone and Telegraph Notes.

A wireless telegraph station has been erected at Batavia, Java, and the transmitting towers were constructed of bamboo lattice-work. Thirty Japanese workmen were employed owing to the unsanitary conditions of the climate, and a Javanese native has been instructed in the use of the apparatus.

◆ ◆

Mr. Marconi has strong hopes of establishing a commercial Transatlantic wireless service in the autumn of this year. All that remains is the completion of a station on the west coast of Ireland. By agreement with the Canadian Government the rate is fixed at sixpence per word.

◆ ◆

The telephone is making rapid strides in Afghanistan. According to the Financial News the most distant stations are now in touch, and other developments are expected. Ghauzni, Kandahar, Herat, Badakshan, Jelalabad, and Khost are all connected, and a connection into Turkestan is shortly to be opened.

◆ ◆

The Government of Manitoba will shortly take over the telephones within its territory. The Bell Telephone Company now operates eighty-five exchanges, and is erecting thirty more. It has let contracts for the delivery of 60,000 poles, and will spend £150,000 in construction work outside Winnipeg. The latter city has the highest calling rate in the dominion—twenty per day—and is now installing a new 10,000 line board.

◆ ◆

By the terms of the convention between the United Kingdom and France regarding telegraphic communication between Réunion and Mauritius, the French Government will lay at its own cost a cable between the two islands; the cable to be opened for traffic within two years of the ratification of the convention, which is to last twenty-five years; the rates from Réunion to Mauritius to belong to the French Government, which also retains the right to remove the cable in Mauritius territorial waters on the expiration of the convention.

◆ ◆

Commenting upon the municipal telephone situation, the Electrical Review says: "It is tolerably well known that the municipal telephone systems have not been built in strict conformity with Post Office engineering standards and that they contain much apparatus of an obsolete type. As in no case has any serious allowance for depreciation been made, there must obviously be a considerable loss to be faced by someone whenever the municipal telephone experiments are wound up. The municipal authorities who have so lightly spent something over half a million on an ill-planned and futile telephone competition expected the loss incurred to fall on the Post Office, but the Postmaster-General and his advisers are apparently not prepared to throw business methods to the winds and to help out the ratepayer at the expense of the taxpayer."

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The Fixation of Nitrogen.

By SIR WILLIAM RAMSAY, K.C.B., F.R S.

When Lord Rayleigh showed, now eleven years ago, that atmospheric nitrogen is denser than nitrogen produced by chemical means from one of its compounds, he and the author of this article showed that the cause is to be traced to the existence of a gas in the air, heavier than nitrogen, to which the name of argon was given. To prepare argon in quantity it was necessary to remove the nitrogen; and the process first employed by Priestley, and afterwards applied with so much success by Cavendish, was chosen. Another process, depending on the rapid absorption of nitrogen by the metal magnesium, was also employed, and on the laboratory scale the latter proved to be the most convenient system for the object in view. Lord Rayleigh, however, followed up Cavendish's method, and was successful in absorbing about 7 litres of mixed oxygen and nitrogen per hour. This was done by forming an arc between platinum poles in an atmosphere of air to which oxygen had been added, and absorbing the oxides of nitrogen formed by causing a fountain of caustic soda solution to play on the top of the flask containing the arc, which served the double purpose of keeping the vessel cool, and of presenting a large absorbing surface to the gases produced by the arc. There is formed by this device a mixture of nitrite and nitrate of sodium; the nitrogen and the oxygen combine to form nitric oxide, NO; this gas unites with excess of oxygen to form nitric peroxide, NO^2; and the peroxide reacts with the caustic soda, thus:—

$$2NO^2 + 2NaOH = NaNO^3 + NaNO^2 + H_2O.$$

Here, then, is a method of procuring combined nitrogen; it is easy to calculate that the air over each square mile of the earth's surface contains enough nitrogen in the free state to afford plant-food for over sixty years world's consumption, if only it were combined; its value would be about £500,000,000 if it were in the form of saltpetre.

Attempts to cause nitrogen and oxygen to combine by electric means have been patented by MacDougal and Howles in 1900; by Kowalski and Moszicki and by Bradley and Lovejoy in 1902; and by Muthmann and Hofer in 1903. Bradley and Lovejoy's process was, until the summer of 1904, carried on at Niagara Falls by the "Atmospheric Products Company"; the other methods have not proved satisfactory. Another process, patented by Birkeland and Eyde, has been at work since 1903: works are being erected at Svaelgfoss, in Norway, which will utilise 30,000h.p. and produce large amounts of nitrate of calcium for direct use as manure. The attempt has been made in all these processes to expose the air to the high temperature of the electric arc and to cool it as rapidly as possible after exposure has caused the combination of a

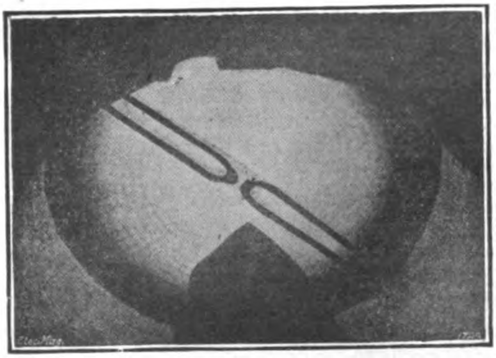
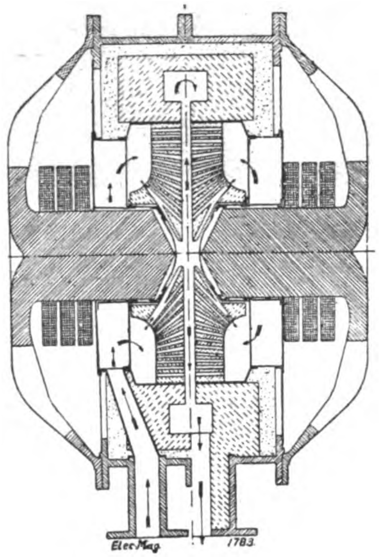


Fig. 3. Photograph of the Arcs produced by the Birkeland-Eyde Process.



Sectional view of the latest Birkeland-Eyde Furnace for extracting Nitrogen from the air.

portion of the oxygen and the nitrogen. Without rapid cooling, the compound decomposes again; and with a thick arc, like that used for lighting purposes, only little air is exposed to the high temperature. Hence the trial of various devices for rendering the arc as thin and extended as possible.

In their latest installation the arcs are confined in flat drums of iron lined with asbestos and mica; the arcs are formed at the ends of hollow copper rods, kept cool by running a current of water through their interiors; and the magnets are furnished with pole-pieces, one of which passes through each axis of the drum. The temperature to which the current of air passing through the drum is exposed is approximately 3000° C.; and it is calculated that one-fifth of the air acquires this temperature. The nitrogen and oxygen combine to form nitric oxide, NO; if this gas were allowed to cool slowly down to atmospheric temperature again it would again be resolved into its constituents; but the arc ceases and the gas is suddenly cooled, so that much of it escapes decomposition and is swept along with the current into absorbers. It issues from the drum at a temperature of 600° or 700°, and it passes through the tubes of tubular boilers and raises steam which is utilised in a manner afterwards to be described.

The nitric oxide, NO, combines with oxygen to form nitric peroxide, NO^2, on issuing from the boiler-tubes; and it then passes through a succession of towers down which water trickles. Nitric acid is there formed, according to the equation :—$4NO^2 + O^2 + 2H_2O = 4HNO^3$. But not all the gas is absorbed; the unattacked air which passes along with it dilutes it to such an extent that at least half escapes absorption. Therefore, after passing the water-towers, it enters a tower charged with milk of lime; and there it is nearly all absorbed, with the exception of about 5 per cent. The lime is converted into a mixture of nitrite and nitrate, according to the equation :—$2Ca(OH)^2 + 4NO^2 = Ca(NO^2)^2 + Ca(NO^3)^2$. Now, nitrite of calcium is useless as a manure; it is the nitrate alone which is valuable. The nitrite must therefore be converted into nitrate. This is done by adding a portion of the nitric acid, condensed in the towers, and distilling. The nitrite is decomposed; nitrous fumes, consisting of a mixture of NO and NO^2, pass over, and the lime is present in the liquor entirely as nitrate. It is this nitrate solution which is evaporated by help of the steam raised in the boilers heated by the escaping gas. The nitrate of calcium may be brought to market in one of three forms: firstly in a fused state, in which it contains 13.5 per cent. of nitrogen; secondly, in crystals; and thirdly, as a basic salt, which forms a dry powder, not turning moist on exposure to air. This valuable suggestion to use the basic nitrate and thus to produce a dry and nondeliquescent marketable article is due to Dr. Rudolph Messel. The extra lime which is introduced adds little to the cost and is itself of manurial value.

The nitrous fumes are not lost; they may either be absorbed in caustic soda, giving

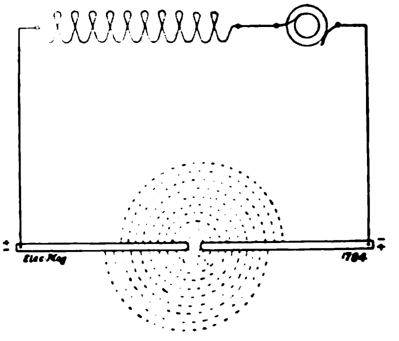


Diagram of connections and formation of Arcs in the Birkeland-Eyde Furnace.

nitrite of sodium, a salt much used by manufacturers of organic dyes, or they may be mixed with the stream of gases which have passed through the boiler-tubes, and pass to the water-towers, when a portion will yield nitric acid and the rest will again be absorbed by lime.

It is also possible to electrolyse the sodium nitrate and to form ammonia and caustic soda; the ammonia can be distilled off and neutralised with nitric acid, giving the valuable product nitrate of ammonium, of use for explosives, the caustic soda being available for again absorbing the nitrous fumes. During electrolysis, oxygen is evolved; it may be introduced along with air into the furnace, for air richer in oxygen forms more nitric oxide in the flame.—Abstract from Times Engineering Supplement.

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The Teaching of Physics.

PROF. J. PERRY, in an address to the Physical Society of London, said that in the early days of the society, when he had the honour of acting as a secretary, and when Guthrie and Foster, Kelvin and Fitzgerald were presidents, no presidential addresses were delivered, and he questioned whether we were not overdoing the business of requiring general addresses, which must almost always have as their theme the progress of science. Seldom did we find in such addresses new accounts of important original work, and he felt the inappropriateness of such an address in speaking before a society whose proceedings were more intense with original work of the best kind than any other society known to him with the exception of the Royal Society. He thought that every young reader of a paper before a scientific society made the mistake of assuming that his audience knew a great deal of the subject so familiar to himself, and hence his paper was not understood. Writers of books on physics assume their readers to be all truly logical students; they use words properly in a technical sense, and forget that many of their readers may use them in the newspaper writer's sense. For example, take the expression "adiabatic expansion." There are people who insist on finding that Rankine, Maxwell, and all others of our most exact writers are not only inconsistent with one another in the use of the expression, but that each is inconsistent with himself. If a portion of fluid expands slowly without gain or loss of heat, we know the way in which its p, v, and t alter as it changes state; this was originally called "adiabatic expansion," and the term has become a technical term for that kind of alteration of p, v, and t, however it may occur. Steam or air may be throttled through a non-conducting reducing valve, but the expansion is not adiabatic, although there is no gain or loss of heat. Steam or air passing along a pipe with friction, if it can only be made to lose heat through the metal of the pipe at exactly the proper rate at every place, is expanding adiabatically. When it is assumed that steam or air flows without friction from a vessel through an orifice, it is said that the expansion is adiabatic, although it is rapid.

Referring to the teaching of physics to students entering upon the engineering profession, the president remarked that such teaching was nearly always slipshod. Many men enter a science college at the age of eighteen or more, knowing nothing of physical science. In the case of a great percentage of such men, it is impossible that they should acquire the scientific habit of thought. It is because so much of this kind of material is dealt with, that much of our teaching is slipshod. Every pupil entering a science college ought to have been experimenting and working graphically and numerically on physical science problems from a very early age, and then our science classes would deal with them in a scientific way. The causes of the unfitness of the average student are two: one that his instincts and habits of thought were not trained from early youth; the other that his teachers in science colleges have absurd and uninteresting courses of study for him. In physics we are dealing with ideas which are not familiar to young students, ideas which can only become familiar in the laboratory. For example, such a simple mathematical idea as that of a decimal cannot be given in elementary schools in less than five or six years, whereas one week of weighing and measuring would give young children familiarity and clear ideas about decimals. Numerous examples could be given to prove that the principles of physics cannot be understood unless there has been early experimental training, and this is the reason why the professors of science in colleges of university rank and the professors in technical colleges obtain such poor reward for their labour. Referring to the many hundreds who every year take science degrees at the universities, and the thousands who pass the London University matriculation examination, Prof. Perry remarked that if that was the standard of excellence of those present, his address could serve no useful purpose. Nothing ought to be compulsory in schools except the study of English and of natural science. The object of a matriculation examination is to test whether a student entering a college will be able to benefit by the course of study there. The only language which ought to be compulsory in the science department of a university is English. A professor of science ought to be allowed to teach his students in the way that seems best to him and he should examine his students himself. Hedge him round with rules and regulations framed by Boards of Studies; tie him down to a syllabus, and the work he will do might be much better, certainly much more cheaply, done by a grinder at low wages. There is no one general elementary course in physics which all students ought to take: neither by their previous training nor from the uses which they will make of the principles of physics are they fit to be taught together. What is wanted is more classes, more rooms, and more teachers.

Platinum in the United States.

The director of the Geological Survey, Mr. Charles D. Walcott, has submitted a report to the United States Senate concerning the recent investigation of the black sands of the Pacific Slope, which is of considerable importance to the electrical industries in general. The immediate necessity for the investigation has been due to the scarcity of platinum in the United States, occasioned by the Japanese-Russian war.

Early in the year of 1905 the Survey sent copies of a circular to all of the placer miners of the United States (about 8000) inviting them to submit samples of the heavy sands collected in placer gold mines. More than 1000 samples were assayed for gold and platinum. These samples were also scrutinised closely to detect the presence of various other minerals which have become industrially useful within the last five years. Among them are chromic iron ore, for the manufacture of paints, chrome steel and bichromate of potash; monazite and zircon, for the manufacture of incandescent gas and electric lamps; magnetic iron ore, for the manufacture of steel, and especially tantalite and columbite, which have recently become very valuable in incandescent electric lighting.

Sands were examined from thirty-four states and territories, and it was quickly recognised that the distribution of valuable minerals in these sands is vastly greater than had previously been supposed. It was discovered that platinum occurs at many localities where its presence had not been suspected, and the majority of the specimens were found to contain gold in appreciable amount. In order to determine whether these valuable minerals could be extracted at a profit, several concentrating machines of the best type were assembled at Portland, Ore., during the Exposition. It was found that from 95 to 98 per cent. of the gold and platinum could readily be extracted from the black sands by concentration on tables of the Wilfrey, Pinder, Christonsen and Woodbury types.

It was found that much larger supplies of high-grade magnetic iron ore could easily be made valuable by concentration of this character from the sands of the Pacific Coast beaches, and from the sluice boxes of placer mines. This addition of wealth would be great if suitable means for smelting these sands could be found, notwithstanding the high price of fuel on the west coast, and the prejudice against these sands on account of their finely divided character. On the other hand, the abundance of water power on the coast has developed electric power at very low rates at many points. To determine whether electric smelting of these ores is practical or not, an electric smelter was built, and steel of good quality was made directly from the ore, with as high a specific output as 18lbs. of steel per h.p.-day—an output equal to the best electric smelting practice in foreign countries, where such processes have been established.

The director states that there is little doubt that the investigation, if continued during the present winter, will lead, within two years, to an addition of from two to five millions of dollars to the output of the placer gold mines of the West, in addition to an adequate supply of platinum and the allied metals, osmium and iridium, and to the development of valuable industries at many points in the West to handle the by-products which this examination shows to be present in these sands.

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

A New Alternating-Current Motor.

By B. G. LAMME.

A PATENT was recently granted the author (and assigned to the Westinghouse Electric and Manufacturing Company) on a type of alternating-current motor, description of which may prove interesting.

Direct-current motors may be operated by either single-phase or polyphase alternating currents provided the reversals of magnetism in the armature and in the field magnet occur simultaneously; but if a motor of the direct-current type is to be operated continuously by alternating currents its magnetic circuits should be laminated throughout and other minor alterations should also be made.

The self-induction of the armature of a motor of the direct-current type when supplied with alternating currents causes the current in that member to lag behind the impressed electro-motive force, and unless such lag is neutralized the efficiency of the motor is impaired. It is proposed partially to neutralize the self-induction of the armature of an alternating-current motor by means of a stationary winding located in slots in the faces of the field-magnet pole pieces, and connected in series with the armature winding, being so distributed that the number of its ampere-turns in each pole face is equal to the number of ampere-turns in that part of the armature which is covered by the winding in such pole face. It is also intended to apply a current of one phase to the armature and neutralizing windings and a current of a different phase to the field-magnet winding. It follows from the disposition and arrangement of windings that the neutralizing effect of the stationary windings connected in series with the armature is instantaneous, that it is equal or proportional to the self-induction of the armature, and that the magnetic relations of the armature and field magnet are not otherwise modified or disturbed.

In the construction of motors having commutators and intended and adapted for operation by alternating currents it has been found to be advisable to provide definite field-magnet pole pieces between which are definite interpolar spaces, substantially as in ordinary direct-current machines, and in

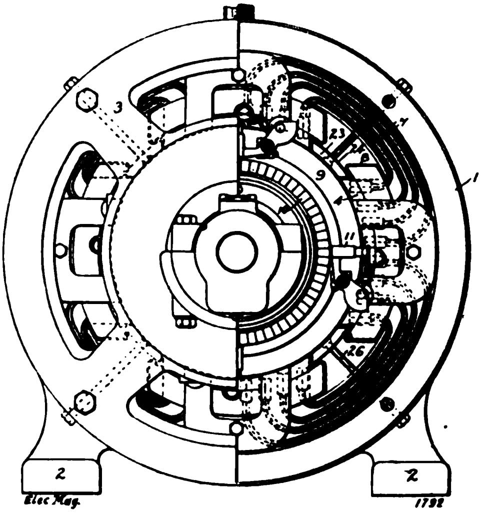

Fig. 1. End view and part section of Lamme A.C. Motor.

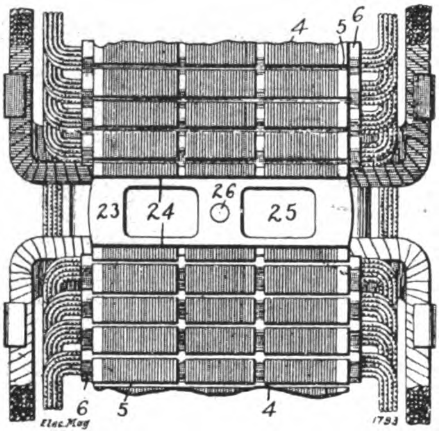

FIG 2. PLAN OF FIELD CORE AND WINDINGS, LAMME A.C. MOTOR.

order to insure a satisfactory power factor in motors of this character it has been found desirable to provide armature ampere-turns, the number of which shall be relatively large as compared with the number of ampere-turns required to magnetize the field magnet. Under such conditions the field distortion caused by the armature ampere-turns would be very great if it were not for the neutralizing winding in the field-magnet pole faces, and even where such windings are employed they do not neutralize the armature ampere-turns in the interpolar spaces. In the case of direct-current motors the armature magnetomotive force in the interpolar space is relatively so small that it has but little effect on the operation of the motor. But in the case of an alternating-current motor having currents supplied to the armature that differ in phase from those supplied to the field magnet and having a large number of ampere-turns in the armature as compared with the number of field ampere-turns, the armature magnetomotive forces exerted in the interpolar spaces may be relatively large. Experience has demonstrated that this effect may be so great under certain conditions as to set up a hunting action in the machine, during which the armature current rises and falls periodically. In such operation the magnetic effect in the interpolar spaces will also rise and fall periodically, and there will be a distorting effect in the field which will tend to cause the hunting action to continue. In order to eliminate this hunting effect conducting plates of comparatively large cross-section and very low resistance are placed between the pole pieces of the motor. These plates act as secondaries to the interpolar field set up by the armature currents, and therefore reduce the field to a comparatively small value, the hunting tendency being thereby substantially eliminated.

Fig. 1 is a view in end elevation of a motor embodying the invention, one-half of the end cap being removed. Fig. 2 is a face view of one-half of each of two adjacent pole pieces; their windings, and the plate located between them. Fig. 3 is an end view of a motor constructed in accordance with the invention and showing the supply circuits as well as the neutralizing windings and plates, and is mainly diagrammatic.

While the invention is not limited to a motor having a specific number of poles, there is here indicated a four-pole motor, each of the laminated pole pieces (4) of which is provided with eight slots (5) adjacent to its face, in which are located neutralizing conductors. One-half of the neutralizing conductors in each pole piece are connected to the neutralizing conductors which are located in the slots of the adjacent half of the adjacent pole piece by means of connections (7), which may be either integral extensions of the conductors that are located in the pole piece slots or separately constructed connectors that are suitably fastened to the projecting ends of said core-slot conductors. In order that the end portions may not interfere with the application and removal of the magnetising coils, they are bent outward in a plane substantially parallel to the end of the motor and then around the adjacent space between the pole pieces so that none of them cross such space.

As shown in Fig. 3, the neutralizing windings (6) (7) are connected in series with the armature winding by means of the brushes

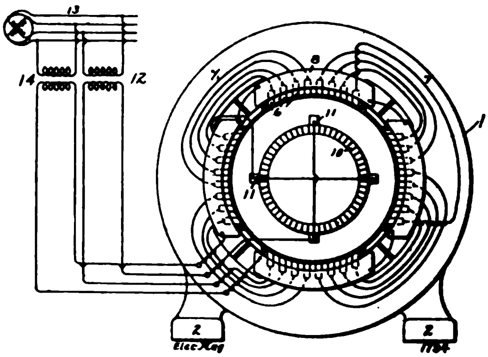

FIG. 3. DIAGRAM OF CONNECTIONS OF LAMME A.C. MOTOR.

and commutator cylinder, and these series-connected windings are supplied with current from the secondary of a transformer (12), the primary of which is connected to conductors corresponding to one phase of a two-phase circuit, and the magnetising field-magnet coils (8) are supplied with current from the secondary winding of a transformer (14), the primary of which is supplied with current from the conductors corresponding to the other phase of the two-phase system. This arrangement is such that the armature self-induction is effectually neutralized except in the interpolar spaces. Since the self-induction of the armature is thus neutralized the current of the phase which is supplied to the armature is maintained in phase with the impressed electromotive force; but the self-induction of the field magnet causes the current of the phase which is supplied to that member to lag approximately 90 degrees behind the impressed electromotive force, so that the currents in the two windings are approximately 180 degrees apart and the reversals of the magnetism in the armature and the field-magnet occur simultaneously, this being the proper condition for satisfactory operation.

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The Boucherot Induction Motor.

Many and various are the devices adopted for improving the starting torque of induction motors, and we have referred to some of these from time to time. In our January issue we illustrated a form of motor having two distinct rotors and stators within one housing, and now particulars are to hand of a motor arranged somewhat similarly, but with resistances inserted across the circuits connecting the leads of the two rotors. The machine was described in detail recently in L'Industrie Électrique, and our illustrations are taken from that source. Fig. 1 depicts diagrammatically the stators, a, a_2, and the rotors, b, b_2; and r, r, r, are the resistances across the rotor circuits. The resistances are only operative when the E.M.F.'s of the two stators differ in phase, and their values are chosen to give the desired starting torque. When starting there is an artificial phase difference between the two stators which is removed gradually as the motor attains speed. Fig. 2 illustrates the connections of a machine in which the phase difference is produced electrically. The bottom diagram shows the connections for starting, the stators being star wound and opposed to each other. In the centre diagram the intermediate position is shown, and here one stator is fully active while the other is short-circuited. In the top diagram both stators are coupled to the line, and in phase with each other. This design has been adopted for motors intended for the driving of centrifugal pumps and ventilators,

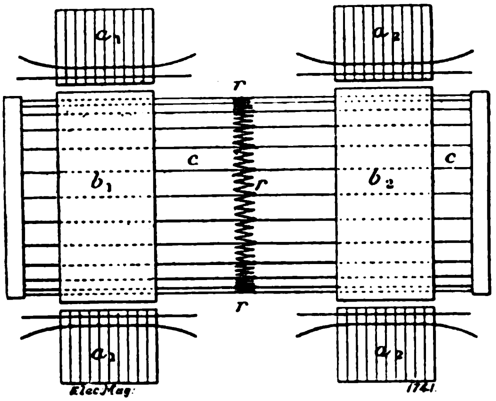


Fig. 1. Diagram of Stators and Rotors of Boucherot Induction Motor.

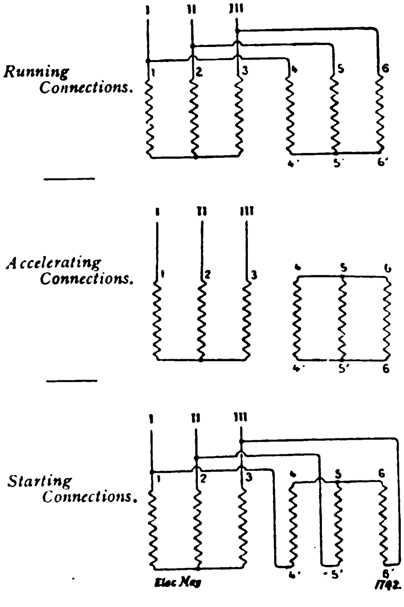


Fig. 2. Diagrams showing the Connections of Boucherot Motor at Starting, Accelerating, and Running.

and every satisfaction has attended its exploitation. A mechanical method of displacing the stators for producing a phase difference is employed with motors which are easily accessible, but in all other cases the electrical method described above is adopted.

Calculation of Dynamos.

A METHOD is given here by M. L. Isambert for predetermining the most economical design of dynamos. For machines rated at less than 100kw. there are generally standard sizes, but for larger machines it is customary to make special designs. The author has compared machines made by different companies, which were exhibited at Paris, and found that they differed considerably in size although having the same rating. It seemed interesting to him to develop a method, based both on theory and practice, which would indicate mathematically the best dimensions. In order to do this it is necessary to adopt certain ratios, which may be found for any particular type of machine. These are, for example, the ratio between the length of the pole-span and the polar arc, the leakage coefficients, &c. He takes up the machine one part at a time, deduces the formulæ for each, and finally brings all these separate formulæ together into a final one representing the relation between the radius of the armature and various other factors. This has the form:

$$R^5 = \frac{100\, a\, \alpha^2 \left(\frac{P}{\omega}\right) p^5}{\omega \gamma \left[7.2 \times 10^{-2}\, p\, g + 0.128\, c\, (p - 0.65)\right]}$$

In this formula, *a* is the cost in francs per kilogramme of copper on the field, and is taken as seven; *c* is 0.35 franc, the price per kilogramme of the sheet iron, and *g* is 0.35 franc, the price per kilogramme of the field casting. Substituting these values, the equation is reduced to the following formula:

$$R^5 = \frac{\left(\frac{P}{\omega}\right) p^5\, \alpha^2\, 10^4}{\omega\, \gamma\, (p - 0.41)}$$

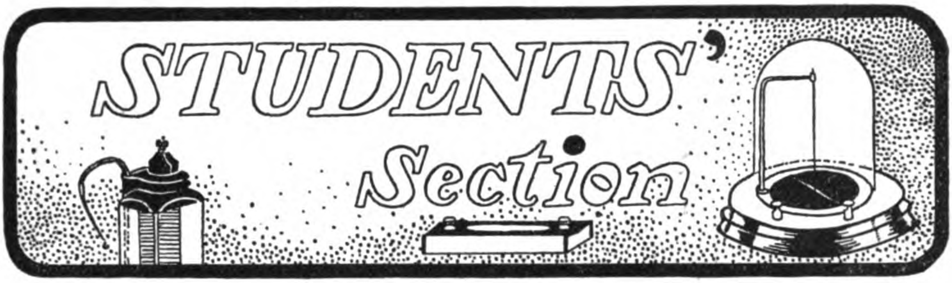
In this, R is the radius of the armature; $\frac{P}{\omega}$ is the specific power in watts per 1000 revolutions per minute, p is the number of pairs of poles, α a factor bringing in the ratio between the armature reaction and the magnetic leakage, and γ is the percentage of the total power of the machine lost in the field. The author has tested this formula by applying it to a number of designs and has found his figures agree with those arrived at from practice. He has found this method very useful in checking the arbitrarily selected dimensions for a new design.—Abstracted from L'Industrie Electrique.

Notes on Design.

The self-exciting alternator designed by the author does not use the multi-circuit arrangement of the field, but can be considered a development from the old principle of rectifying commutator. While in ordinary generators the field current is controlled by hand regulation, this machine employs a three-phase field rheostat in which the voltage drop is automatically cut down to the desired extent by a three-phase current forced through the rheostat in opposite direction to the field currents. The current used for reducing the drop in the rheostat is taken from a transformer connected in series with the armature circuit. In this way the field current is regulated with respect to the power-factor and to the amount of current taken from the generator.—E. F. Alexanderson, American I.E.E.

* *

Mr. Marius Latour has been granted a patent for a method of preventing sparking in commutator motors. The inventor arranges the brushes so that no coils are short-circuited, and yet the armature is not open-circuited as the brushes pass from segment to segment. The commutator has alternate live and dead segments, and several brushes of each polarity are distributed around it, each brush having a width no greater than that of a commutator segment. The circuit through the armature is always closed, although the circuit through each brush is alternately opened and closed, because there is employed a second set of brushes connected in parallel with the first, so arranged that one set is in engagement with live segments at the instant that the other set is in engagement with dead segments. Sufficient resistance is inserted between the parallel-connected brushes to limit the short-circuit current to any desired amount, and provision is made to decrease the amount of this resistance as the motor comes up to speed.



STUDENTS' Section

Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Short-circuit Torque on a Shunt Generator.

By J. PALMER.

When considering the advisability of doing away with overload devices of any kind between generator and bus bar and relying on reverse-current relays only, the question arises, In the event of a "short" what harm is likely to befall the machine?

The following is an attempt to predict the maximum torque that is likely to come on a shunt generator when its brushes are short-circuited; provided, of course, that the fly wheel and steam engine are able to furnish it. When the "short" occurs the current in the armature will rise at a rate which depends upon the time constant of the circuit. For the present it is assumed that this current rise follows a straight line law.

Such a curve is shown in Fig. 1, where time is plotted horizontally and current vertically; the point 1 representing full-load current of the machine.

Owing to the lead of the brushes the armature has a demagnetizing component, or back-ampere turns; when the back-ampere turns equal the magnetizing ampere turns the resultant field will be zero.

Modern machines are designed for a constant brush lead, and the ratio, full-load ampere turns on the fields divided by full-load back-ampere turns, gives that value, in terms of full-load current, to which the armature current must rise in order to entirely demagnetize the fields.

This ratio is denoted by A, and is given in Table I. for several actual machines.

Referring to Fig. 1, where the value of A is taken as 7: When the current in the armature is at 1 the field is at its strongest, and when the current has risen to 7 the resultant field is zero. Therefore if the open-circuit characteristic which shows the relation existing between field and magnetizing force be plotted as shown, we have at any instant the corresponding values of armature current and field strength. From these we can plot the torque curve, as shown, which has a maximum value of 2.94 in terms of full-load torque. In the same way we can plot a number of torque curves for different values of A and obtain their maxima.

In Fig. 2 this has been done, using the same open-circuit characteristic as in Fig. 1, and from which we obtain the law—

Maximum short-circuit torque (in terms of full-load torque)

$$= A \times .36 + .41.$$

Actual values for the maximum short-circuit torque have been worked out in Table I.

The assumption of a straight line law growth of current in the armature has been made, but it will be seen that, while A remains constant, there is only one value of armature current and field strength which can exist together at the same instant; and that, therefore, the shape of the current curve will have no effect on the value of the ordinates of the torque curve, but will simply distribute them differently with regard to time.

The assumption has also been made that the field ampere turns remain the same during the time of short circuit. This, of course, is not so, as the volts across the shunt are falling all the time. The effect of this will be to flatten the curve of field

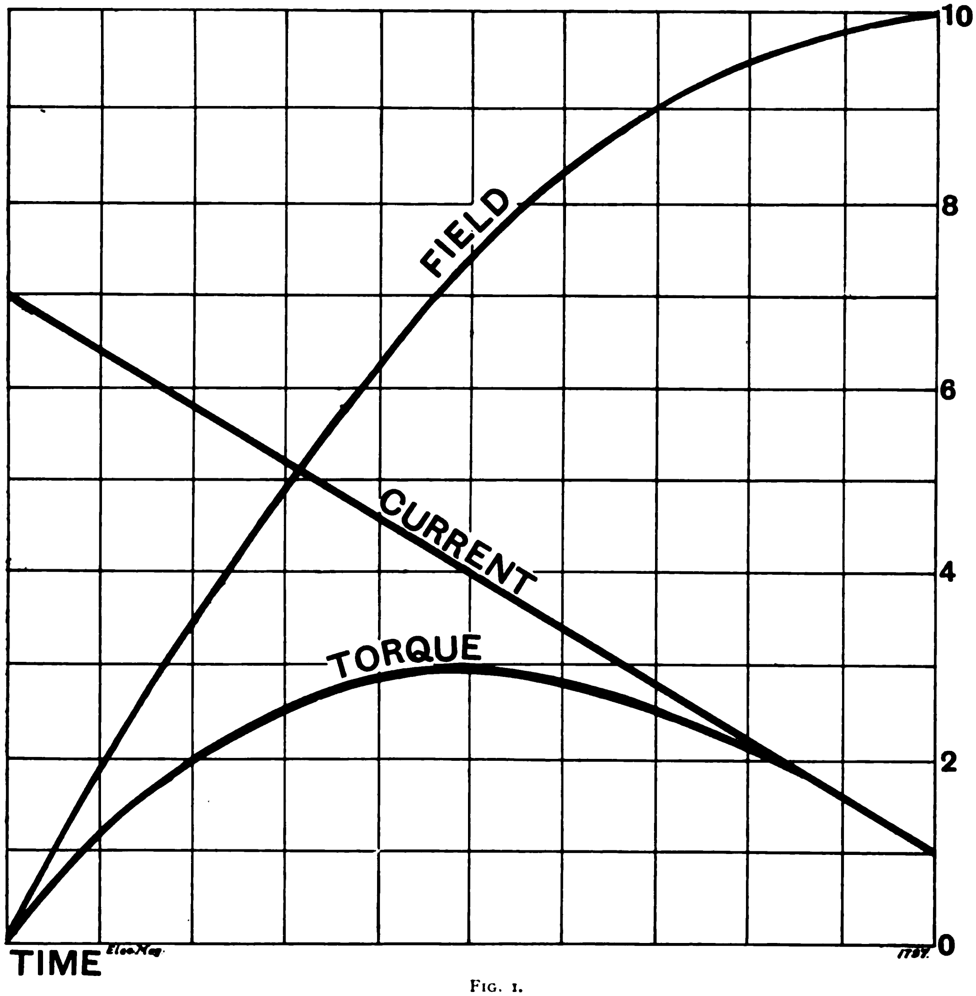

FIELD
CURRENT
TORQUE
10
8
6
4
2
0
TIME

FIG. 1.

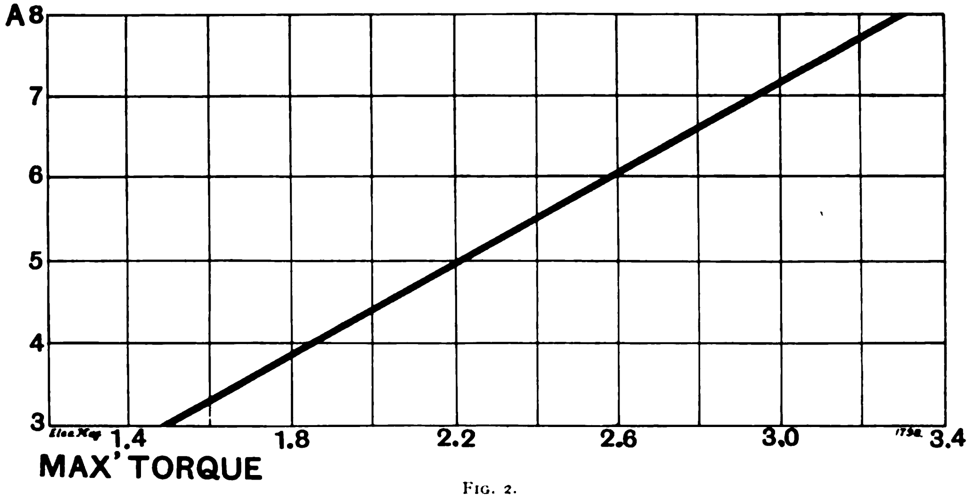

A8
7
6
5
4
3
1.4
1.8
2.2
2.6
3.0
3.4
MAX' TORQUE

FIG. 2.

strength and therefore reduce the maximum torque.

The values of the maximum torque in Table I. have all been obtained from the open-circuit characteristic as drawn in Fig. 1, which is the mean of a number of different machines. Had the curve been more bent the maxima would have been higher; if flatter, lower.

Bearing the above points in mind we may say "Under short-circuit conditions the maximum torque (in terms of full-load torque) on a shunt generator will probably be less than, but will not exceed, the values given in Fig. 2.

TABLE I.

Output in KW.	Designer.	A.	Maximum Short-circuit Torque.
1500	Parshall	7.3	3.0
200	Parshall	5.8	2.5
300	Moore	7.3	3.0
250	Parshall	7.3	3.0
400	Hobart	3.8	1.8
1000	Hobart	4.7	2.1
1600	Hobart	5.3	2.3

Three-Phase-Single-Phase Transformation.

By CHARLES F. SCOTT.

"IT is desired to take three-phase current from the power-house bus-bars and convert it to single-phase current without unduly unbalancing the three-phase system. A sketch of the transformer connections proposed is shown in Fig. 1. Certain engineers advise that this will produce unbalancing of the three-phase system. Why is this so? Is there a possible rearrangement of connections which would obviate this result?"

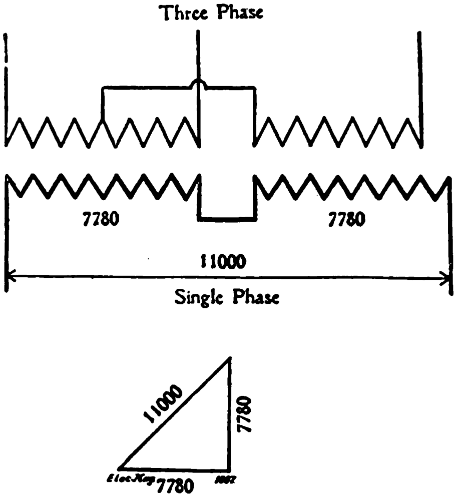


FIG. 1. DIAGRAM OF THREE-PHASE-SINGLE-PHASE TRANSFORMATION.

In connection with various methods, which are from time to time proposed for operating a single-phase circuit from a three-phase generator, there is a general principle which is universally applicable. In a normally operating symmetrical three-phase system the flow of energy is uniform. It is comparable mechanically to the continuous flow of energy through the instrumentality of a belt or from an engine where two or more cylinders with connecting rods are connected to a common shaft, their cranks being set at the usual angles. The single-phase system, on the other hand, has as its characteristic an intermittent flow of energy. At certain moments the energy is zero. It is therefore impossible to convert from three-phase to single-phase and continue the normal operation in both systems unless there be some provision for storage of energy, such, for example, as a rotating armature, which may be driven by a three-phase current and deliver single-phase current. The armature receives energy at a uniform rate and gives out energy at a periodically varying rate. The excess energy received during alternate intervals is stored in the form of mechanical energy in the armature; in the intermediate intervals it is delivered to the single-phase circuit. In this manner the average energy of the single-phase system is equal to the uniform energy of the polyphase system. Such a means of storing energy, however, is not found in ordinary transformers.

The foregoing consideration is a conclusive answer to the proposition that single-phase power can be taken by means of ordinary static transformers from a three-phase system without unbalance.

In the diagram representing the ordinary three-phase-two-phase transformation by means of two transformers, the two secondary windings, which ordinarily deliver two-phase current, are in this case connected in series for supplying a single-phase circuit. The currents in the two windings must therefore be alike in phase instead of differing by ninety degrees, as in a normal two-phase circuit. The electromotive forces on the individual secondary coils still differ in phase by ninety degrees. The currents which would flow through resistances, connected respectively to the individual coils, would likewise differ in phase by ninety degrees. But, when a resistance is connected across the two coils in series, the same current will flow through both coils and its phase will be midway between the phases of the currents which the coils would produce if acting independently. It follows, therefore, that the phase of the "single-phase current," which is delivered by the two secondary coils in series, lies between the phases of the electromotive forces, *i.e.*, the maximum value of the current lags behind the maximum value of the electromotive force in one of the coils and leads that on the other coil. Hence the resultant current is a lagging current in one transformer and a leading current in the other.

The current in a primary winding of a loaded transformer has its maximum and zero values at practically the same instant as the current in the secondary. In the transformer, which has a tap from the middle of its primary winding, the current in this winding is the resultant of two components; one is the primary current, which produces secondary current in this transformer, and the other is the current which is received from the other transformer. As this current divides and flows equally from the centre through the two halves of the winding in opposite directions around the core, it produces no effect upon the secondary. In normal three-phase two-phase transformation, the two components in each half of the winding differ in phase by ninety degrees. When, however, the final secondary circuits are connected in series, these two component currents are of one phase. The current which enters at the middle point of the primary divides and flows one-half in the same direction as the primary current and the other half in the opposite direction from the primary current in this winding. Hence the resultant current is found by direct addition in one-half and subtraction in the other half. The result is that the current in the three wires from the three-phase generator is single-phase current, one wire constitutes one side of the circuit and the other two wires carry the return current. The three-phase generator is, therefore, badly unbalanced.—Electric Journal.

The Waste of Time.

By E. S. McLELLAND.

An address before the Progress Club, Trafford City, U.S.A.

WHAT is time? The duration of one's life; the hours and days which a person has at his disposal. Let us look into this matter and see in how many ways we can waste it, and as we pass quickly over various ways may I ask you to make at least a mental note of the one or more ways you employ in the waste of the most precious thing you have at your disposal?

We are very like to think only of "soldiering" when the waste of time is under discussion. In itself this form is bad enough, though in many cases it leads to worse methods. You are all familiar with this way of wasting time, and you are, many of you, so free from so common a method as not to use it, I am sure. We all despise a man thoroughly of whom it is said, "He soldiers during working hours." But soldiering is only one of the many ways of wasting time. Let us see in what other ways we can waste time!

The most common cause of the waste of time arises from inaccuracy in our work. Let me lay some stress on this point. It is one of the greatest sources of loss to the man, the employer and the world. If we are inaccurate in our work, we have wasted not only our own time, but the time of all those who are dependent upon us for the proper prosecution of the work after it leaves our hands. Let us take a concrete example of what will happen in one of the departments if an error is only made by one man.

A drawing is made under the direction of a first-class engineer, who pays much attention to the general design; an error creeps in, unnoticed, due to inaccurate work or faulty instructions; the design is finished; it is passed to the detailer, from the detailer to the tracer, from the tracer to the blue-printer, from the blue-printer to the checker, from the checker to the foreman draughtsman, from the foreman draughtsman to the chief engineer, and, if the error is found, then it goes back to each man, consuming the time of possibly two or three hours. Now, suppose the error is not discovered and the drawing goes to the pattern shop, foundry, machine shop, erecting shop; the machine is shipped, and when erected is found defective and a part must be replaced by one of proper design. Who can measure the waste of time, not only of the man who made the error, but of all those who contributed to finishing the piece?

How many of us waste not only our own time but that of others by not paying attention to the manner of making our wants known? If we expect the other man to accomplish our wishes we must convey them in a clear, unmistakable manner, leaving out no detail or thought we may have had upon the matter in hand, and tell it all in the language of the other man, so that he may get the correct meaning. Now this is one of the most difficult things we have to do, for it calls for a very accurate knowledge of the capacity of every man under our direction. Each man's work must be suited to him. If we do not accomplish this we waste our time, the man's time, and the cost to the employer can scarcely be estimated in dollars and cents. This relates not only to those in charge of departments or gangs, but to the youngest employer. Get the habit of telling what you want so that the other man will know what to do or what to get.

Young man, the less idling you do the better off you will be. Benjamin Franklin said: "Dost thou love life? Then do not squander time, for that is the stuff life is made of."

And W. E. Gladstone has said:—"Believe me when I tell you that thrift of time will repay you in after life with a usury of profit beyond your most sanguine dreams, and that the waste of it will make you dwindle alike in intellectual and in moral stature beyond your darkest reckonings.

"One of the most important lessons for any man or boy to learn early in life is the economy of time. It is a truth not to be refuted that lost wealth may be replaced by industry; lost knowledge by study; lost health by temperance or medicine; but lost time is gone for ever."

Economy of time will furnish you with a working capital which nothing can rob you of, for capital is nothing more than the abstinence from present gratification for the sake of future needs.

Do not let me hear that you do not have any time to spare. You have all the time there is, and, what is more, go hunt out the men in your own community that have done the most for their own and the general good, and you will find them to be almost uniformly the overworked class, men well nigh busy to death, who seem almost swamped with cares, who keep up a ceaseless activity from January to December; and yet in nine cases out of ten men of this type, busy as they may be, will be found capable of doing a little more, and you may rely upon them in their busiest seasons with more assurance than upon the idling man or the dawdling loafer. It seems far easier for one who is always exerting himself to do a little more for an extra purpose than for him who does nothing to "get up steam." Give a busy man ten minutes to write a letter and he will dash it off at once; give an idle man a day and he will postpone it until to-morrow or next week.

You young men do not perhaps realise that your actions outside of business hours are, in many cases, known to your superior officers, and that the way you spend your time has weight with them as to your future.

The small stones that fill up the crevices are almost as essential to a firm wall as the great stones. And so the wise use of spare time contributes not a little to the building up of a man's mind and character, in good proportion and with strength. Above all, do not waste the time given you in loafing either upon the street corner or in any other place that is not elevating. Economise your time. What does it cost a man to waste time in this manner? Such an one will cease to progress; such an one will begin to vegetate; such an one will stand still for a time and he will go backward and downward until he is no longer in the race, and over his tomb may be well inscribed "A failure from waste of time." Time, my young friend, is your most valuable asset; do not waste one precious minute. The man who knows the ecomony of time will know the art of spending it, just as the man who knows the art of economising and saving money knows the value of it.

Men must know that in this theatre of man's life it remaineth only to God and angels to be lookers on.—Bacon.

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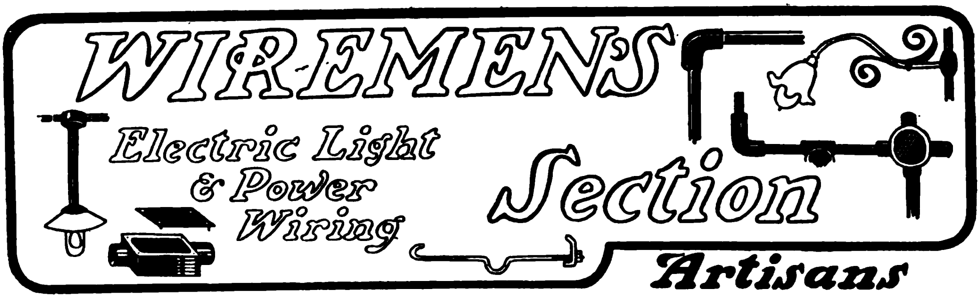


Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON.

(Continued from p. 113.)

OUR third point—heating—may be subdivided into three divisions—(*a*) commutator and brushes, (*b*) bearings, both of which have been dealt with under generators, and (*c*) armature and field coils. In most instances the description given as to causes of heating in generator windings apply to motors. Taking the armature first, the following additional points should be observed: Whereas with a generator the reversing of a coil in the armature windings will set up general heating, in the case of a motor one half of the armature will be considerably hotter than the other. The cure for this is as previously given.

Another divergence in the treatment of motor faults as compared with those on generators occurs in the case of damp coils. If it is found that when a motor is started without load excessive current is shown by ammeter, particular care should be given to it at once. First take an insulation test. This will probably be a bad one. Then let machine run for, say, fifteen minutes. Armature will give off a strong smell when hot as described in the case of generators. The best method of dealing with this is to remove the armature and dry out. But as this is often a matter of great inconvenience the following process will be found useful.

First obtain a low voltage supply. In the case of a 440-volt motor about 40 volts is required. Should you not have accumulators at hand it is practically certain that a lower pressure is in use for lighting. Reduce this by means of a resistance to the voltage given. Connect up to the armature carefully and see that about 50 per cent. above normal amperage flows—in the case of a 10h.p. motor say 30 amperes. On no account must shunt be closed. It is better to disconnect this altogether. The exciting field is not required, the armature field taking its place. If these conditions are carefully observed the motor will run at its proper speed and should be left running for about five or six hours. Then replace all connections to normal conditions.

When a motor runs at less than its proper speed—accompanied by great heating generally—provided it is not an error in design, it is caused by an excessive shunt current, and this should be reduced until the motor reaches its proper speed.

Next we come to faults in speed, to which the last paragraph also applies.

The most frequent cause of the motor speed being too low is excessive load. The electrician should satisfy himself on this point by means of an ammeter. Should it be impossible to alter the load, the only alternative is to bring up the speed of the shafting or machinery driven by decreasing the size of the motor pulley to that required, basing your calculations upon the actual speed of the motor.

But before anything of this kind is done it is important that all other likely causes have been sought for and proved non-existent.

Exactly the same conditions would arise through (1) a tight bearing, (2) line voltage below that for which motor was built, and (3) bad contacts.

Should the low speed when on full load be accompanied with an excessively high speed on light load it will be found that the field is too weak and armature current consequently too great. Examine all connections carefully, both armature, shunt, and field. One of these will be found to be faulty or incorrect, provided always that it is not a maker's fault.

The other extreme, *i.e.*, speed being too high, depends on the type of motor. In a compound-wound machine the speed may step up with the load, such being caused by an error in connecting up, which may easily escape notice. The two windings, *i.e.*, series and shunt, must act in harmony and flow in the same direction. The conditions mentioned show that this was not the case, but were opposing each other. The remedy is obvious.

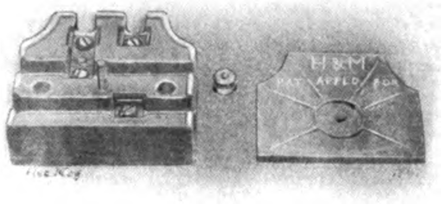
Should excessive speed be accompanied by "wheel" sparking, that is, rings of sparks almost continuous round the commutator, it will be found that the winding of the armature has broken down in one or more places. Examine commutator, and should above be the case, the segments will be found badly burnt.

In the case of a series motor it is only a question of load. As the main current is the cause of excitation it follows that the smaller this is the greater the speed. Series motors must not be run light, and should, wherever possible, be mechanically connected to their work.

A final cause of high speed is the question of line voltage. If this is above that for which motor is built the machine will race.

Our last item in this connection is a troublesome one. I refer to minor faults. So many little things occur from time to time on individual motors that the most comprehensive article could not cover them all. It is best for the electrician to make himself acquainted as far as possible with the construction of each motor he may be called upon to handle. Brush troubles are items of annoyance to most, but by a little careful study these can always be eliminated. One point that has not been touched upon is that of noise. Motors vary considerably in tone, and tq some customers a noisy motor is a cause of great annoyance. As long as the armature shaft is true in its bearings and chattering does not occur on the brushes the electrician is practically helpless. The fault lays with the designer of the motor and the makers.

The writer does not suggest that he has exhausted the list of faults on d.c. motors, but it will be found that those dealt with are the ones most frequently met with, and a knowledge of how to treat them cannot fail to be of utility to workers in this branch of our trade.



A Useful Wiring Accessory: a Porcelain Cross-over Block for Casing Work, Avoiding Joints.

We shall next take d.c. motors and connections as applied to lift, crane, and tramway work, afterwards proceeding to deal with a.c. machines.

(*To be continued.*)

Notes.

It would be worth while if electricians generally gave a little attention to the revival of the inter-pole motor. Although generally described as something new, the inter-pole motor is a very old contrivance, and why it has been left for 1906 to bring it into use is somewhat of a puzzle. The idea of auxiliary commutating poles has been before engineers for at least fifteen years. Till now, it has never got beyond casual use. There are manifest advantages in these motors and at the same time there appear to be many disadvantages, but the manufacturers who are pushing them deserve all credit for doing so, as there is not the slightest doubt but that it lowers the cost of motors above 10hp. This should mean increased work for wiremen.

Why miss this?

Foremen and others wishing to augment their income without in any way interfering with present employment would do well to write for particulars to "Amsoc," c/o The Electrical Magazine, 4, Southampton Row, London, W.C.

N.B.—No fees of any kind.

The World's ELECTRICAL LITERATURE

Power.

Articles.

Electrical Equipment of the Louisville and Nashville R. R. Shops.	*Elec. Wld.*, 23/2/06.
Motor Drive and Machine Shop Economy. E. R. Douglas.	*Elec. Rev.*, N.Y. 10/2/06.
Electrical Driving of Cold Storage and Ice Making Plants. S. F. Walker.	*Elec. Rev.*, N.Y. 10/2/06.
Power from Lake Michigan. A. D. Adams.	*Elec. Rev.*, N.Y. 10/2/06.
Adirondack Power. A. D. Adams.	*Elec. Rev.*, N.Y. 24/2/06.
New Power Plant of the Paris Metropolitan System. B. F. Hirschauer.	*Elec. Rev.*, N.Y. 24/2/06.
How may Niagara Falls best serve the interests of Mankind? O. E. Dunlap.	*Western Electn.* 17/2/06.
Transmission line from Niagara Falls to Syracuse. O. E. Dunlap.	*Western Electn.* 24/2/06.
Hammetschwand Electric Lift on the Buergenstock. A. Gradenwitz.	*Western Electn.* 24/2/06.
A new design of Aerial Tramway. G K. Davol.	*Jrnl. Elec. Power & Gas, Feb.*/06.
Transmission Plant of the Vancouver Power Co.	*Jrnl. Elec. Power & Gas, Feb.*/06.
Greenwich Power Station of L.C.C. Tramways.	*Light Rly. & Tram. Jrnl.* 2/3/06.

Papers.

Portable Electrical Tools and their application to Industrial Purposes. A. Stewart.	*Glasgow Tech. Coll. Sci. Soc.*, 3/3/06.
Electricity in Mines. R. G. Mercer.	*Bhm. Elec. Club.* 10/3/06.
Electricity as a Motive Power and the Potteries Industries. C. H. Yeaman.	*English Ceramic Soc.*
The Design and Construction of Large Gas Engines. T. H. Hurst.	*Inst. Mech. Engrs.* 12/3/06.
Some Notes on Motor Driving. W. J. Belsey.	*Dublin I.E.E.* 8/2/06.

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Electric Railway Engineering. J. E. Webster.	*Elec. Journal, Feb.* 06.
Functions of a Good Draft Gear. A. Stucki.	*Railroad Gazette*, 23/2/06.
The Strang Gasoline-Electric Rail Motor Car.	*Railroad Gazette*, 23 2 06.
Electric Automobile Development at Rockford (Ill.).	*Elec. Wld.*, 17/2/06.
Comparison between Single-phase and Three-phase Equipment for the Sarnia Tunnel. C. L. de Muralt. (See Traction this month.)	*Strt. Rly. Jrnl.* 17/2/06.
The Snow Problem in Marquette. H. Baluss.	*Strt. Rly. Jrnl.* 17/2/06.
The effect of Snow on Third Rail. (See Traction this month).	*Strt. Rl. Jrnl.* 17/2/09.
Kinks and Practice in the Joliet and Chicago Electric Railway Shops.	*Strt. Rly. Jrnl.* 24/2/06.
*Recent Tests with 15,000 volt One-phase Swiss Locomotive.	*Strt. Rly. Jrnl.* 24/2/06.
The Management and Equipment of Pleasure Resorts.	*Strt. Rly. Jrnl.* 24/2/06.
Warren and Jamestown Single-phase Railway. (See Traction this month.)	*Elec. Rev.*, N.Y. 17/2/06.
St. Gallen-Trogen Interurban Railway in Switzerland. F. Koester.	*Westn. Elect.* 10/2/06.
New Simplon Tunnel Electrical Equipment. F. C. Perkins.	*Westn. Elect.* 24/2/06.
Self Induction Effects in Steel Rails. E. Wilson.	*Electrician*, 23/2/06.

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Single-phase Railway Working. T. H. Schoepf.	*Manch. I. E.E.* 27/2/06.

London Traffic. G. S. C. Swinton.	*Soc. of Arts.* 28/2/06.
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Central Station Practice.

Articles.

*Steam Consumption of Reciprocating Engines. T. Stevens and H. M. Hobart.	*Elec. Wld.*, 17/2/06
*Economy of Steam Turbines Compared with that of Reciprocating Engines. T. Stevens and H. M. Hobart.	*Elec. Wld.*, 24/2/06
Starting Rotary Convertors.	*Canad. Elec. News Feb.*/06.
Steam Turbines. W. H. Booth.	*Elec. Rev.*, 2/3/06.
Test on a 1500kw. Curtis Turbine.	*Electn.*, 2/3/06.
The Operation of Circuit Breakers and Fuses. E. W. Marchant and F. R. Lawson.	*Electn.*, 2/3/06.

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Economic Considerations on the Employment of Storage Batteries. J. R. Salter.	*Manchester I.E.E.* 13/3/06.

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Articles.

The Lighting Problem in Residence Streets. H. S. Knowlton.	*Elec. Wld.*, 23/2/06.
Street Lighting. M. Bloch.	*Jr. F. Gasbel*, 3/2/06.
Electric Lighting as Applied to Commercial Advertising. B. I. Dasent.	*Jrnl. Elec. Power and Gas. Feb* /06.
Electric Lighting at Tientsin.	*Elec Rev.*, 23/2/06.
Effective Shop Lighting. W. A. Toppin.	*Elec. Rev.*, 23/2/06.

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Transmitting Distances in Wireless Telegraphy. L. D. Wildman.	*Elec. Wld.*, 10/2/06.
*Advantageous Use of Highly Magnetic Metal in Radiation Conductors. J F. King.	*Elec. Wld.*, 10/2/06.
Protection of Telephones from Wireless Disturbances. C. R. Siegel.	*Elec. Wld.*, 10/2/06
Modern Telephony in Theory and Practice. W. H. Radcliffe.	*Telephony, Feb.*/06.
Telephone Maintenance. S. G. McMeen.	*Telephony, Feb* /06.
Telephone Engineering in "the Country God forgot." G. B. Ellison.	*Telephony, Feb.*/06.
The Automatic Telegraph as a Public Utility. R. Hitchcock.	*Teleg. Age*, 1/3/06.
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How to Secure Efficiency Among Operators. Miss T. Barnes.	*Sound Waves. March*, /06.
Space Telegraphy in the Dutch Indies. A. Gradenwitz.	*Westn. Electn.* 17 2/06.
German Submarine Cable Enterprise.	*Elec. Rev.*, 23/2/06.

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How to Improve Telephony. W. Duddell.	*Royal Inst.* 16/3/06.
Wireless Telegraphy. F. A. Lawson.	*Liverpool, Eng. Soc.*, 27/2/06.

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Articles.

Dielectric Strength of Air. Russell.	*Phil. Mag. Feb./06..*
Inductance and Capacity. M. Hilpere.	*Elek. Bahnen.* 3/2/06.
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*Electrical Nature of Matter and Radio-activity. H. C. Jones.	*Elec. Rev.*, N.Y. 10, 17/2/06.

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The Corpuscular Theory of Matter. J. J. Thomson.	*Royal Inst.*, 3/3/06.
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The Internal Energy of Elements. F. Soddy.	*Glasgow I.E.E.* 13/3/06.

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Refractory Uses of Bauxite. A. J. Aubrey.	*Elec. Chem. Ind. Feb./06.*
The Carborundum Furnace. J. A. J. Fitzgerald.	*Elec. Chem. Ind. Feb./06.*

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Articles.

*The Re-incarnation of an Electrical Idea. F. J. Sprague.	*Elec. Wld.*, 24/2/06.
The Magnetism in Induction Motors. H. F. and H. W. Connell.	*Elec. Wld.*, 24/2/06.
Armature Reaction in Three-phase Generators. Sumec.	*Elek. und Masch.* 28/1/06.
The Single-phase Series Motor.	*Elek. und Masch.* 7/1/06.
A Contribution to the Theory of the Single-phase Induction Motor. V. A. Fynn.	*Elec. Rev.*, 2/3/06.
The American System of Fuse Standardization. A. Schwartz.	*Elec. Rev.*, 2/3/06.
Phase Meters and Their Calibration. W. E. Sumpner.	*Electn.*, 23/2/06.
A Study in the Design of a 500kw. Continuous Current Generator. M. Breslauer	*Electn.*, 9/3/06.
The Insulating Cost in the Manufacture of Dynamo Electric Machinery. H. M. Hobart.	*Elec. Eng.*, 16/2/06.
Graphical Determination of the Dimensions of Magnet Coils. C. Kinzbrunner.	*Elec. Eng.*, 2/3/06.

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Distribution of Magnetic Induction and Hysteresis Loss in Armatures. W. M. Thornton.	*Newcastle I.E.E.*, 26/2/06.
Acceleration and Accelerometers. A. P. Trotter.	*Junr. Inst. Eng.* 2/3/06.
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New Iron Cored Instruments for A. C. Working. W. E. Sumpner.	*Bhm. I.E.E.* 14/3/06.

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Articles.

Induction in Transmission Circuits. C. F. Scott.	*Elec. Journal. Feb./06.*
How to Make a Slide Rule for Wiring Calculations. E. P. Roberts.	*Elec. Journal. Feb./06.*
Alternating Laboratory Testing. G. H. Rowe.	*Jrnl. Elec. Power and Gas, Feb./06.*
Evening Students in Electrical Engineering. T. A. Locke.	*Elec. Eng.*, 9/3/06.

Wiremen.

Articles.

Cold Bending of Pipes for Electrical Wires. R. G. Grayne.	*Western Electn.* 3/2/06.

Papers.

Electrical Wiring of Small Buildings. R. Robson.	*Newcastle I.E.E.* 5/2/06.
Conduit Wiring for Electric Installations. L. M. Waterhouse.	*Elec. Contractor Assoc.*, 20/2/06.

"Mathematical Drawing Instruments and Materials."

A. G. THORNTON. London: Percival Marshall and Co., Poppins Court, Fleet Street, E.C. Price 3s. 6d.

Every draughtsman should have a copy of this handy little volume as it contains so much information in little space. There are times when the best men are in need of advice no matter how familiar they are with the details of a subject, and for this reason we commend to the notice of draughtsmen Mr. Thornton's book. In like manner it will be found useful by students who are generally more in need of advice on the subject of instruments than older members of the engineering profession.

"The 'Practical Engineer' Pocket Book, 1906."

Manchester: Technical Publishing, Co., Ltd., 287, Deansgate. Price 1s.

This eminently practical pocket book has now reached its nineteenth year of publication, and has been revised and enlarged to include several important subjects; among these are tests of mechanical stokers and forced-draught systems; types of indicators; flow of air, steam, gas, and water through pipes; emery wheels; suction gas producers, &c. The book includes a useful electrical section.

"The 'Practical Engineer' Electrical Pocket Book, 1906."

Manchester: Technical Publishing Co., Ltd., 287, Deansgate.

A handy pocket book, which should lie next the heart of every electrician. This is how we can best recommend the 1906 edition of this useful *multum-in-parvo*. Among the important additions is matter relating to fault localizing, synchronizers, multi-phase distribution, rotary converters, and electro-chemical processes. In parting with a humble "bob" for this magazine of information the electrician will make a sound investment.

"Les Télégraphes en Europe."

By E. GUARINI. Paris: V. Dunod, 49, Quai des Grands Augustins. Prix 5 francs.

A useful brochure is a collection of data regarding European telegraph systems and should prove very valuable for reference. It is in handy form and is well sectionized, so that one can without difficulty find particulars of the entire apparatus used from instruments to line. The chapter on the networks of various countries is particularly "meaty," and condensation has been carried to an extreme which makes it useful. The last chapter (IV.) deals with simultaneous telegraphy and telephony over the same circuits. The work brings the data of the subject up to the end of 1905.

"The Electrical Engineer's Central-Station Directory."

London: BIGGS & SONS, 139-140, Salisbury Court, Fleet Street, E.C. Price 5s.

The 1906 edition of this valuable Directory is, as might be expected, considerably more bulky than its predecessor. We do not need to inform our readers of its arrangement or scope, as these must be well known to them. In commending it again to the notice of central-station engineers we will merely say that its utility is in no way impaired by necessary additions, and that its information regarding British, home, and colonial stations will be found as reliable and up-to-date as heretofore. The volume is an admirable testimony to the advances made by electricity supply and electric traction in so short a period as twelve months.

"Continuous Current Armatures." "Alternating Current Windings."

By C. KRINZBRUNNER, A.M.I.E.E. London: 1906. Harper Bros., 45, Albemarle Street, W. Price 3s. 6d. each nett.

A would-be student of dynamo design may well shrink from a close perusal of books like "Armature Windings" or "Polyphase Electric Currents" (if he is fortunate enough to possess these standard works), but he will not hesitate to lay out three-and-six on such inviting looking books as those now before us. The first mentioned, for instance, has only three chapters, and is a work of some seventy-eight pages, so that the beginner need not be scared by bulk. He can, in fact, regard the book as a possible *hors d'œuvre* to a more substantial meal for a rapacious mind. The type and illustrations at once attract the reader, and the nomenclature is of the simplest kind. The elements are rapidly passed over, and the reader will soon be wrapped in the thread of the subject. The author is to be commended for taking up the discussion of only those designs and methods common to present practice, as by so doing the appeal of his work is extended to winding artizans and workshop hands desirous of gaining a broader knowledge of their particular tasks. The first chapter, on the theory of windings, deals with parallel, series, and series parallel windings, after the opening pages on the simple elements of the subject. In chapter two the construction of drum windings is taken up, and hand, bar, evolute, barrel, and former windings are separately treated. The final chapter, on the construction of armatures, deals with mechanical details.

The volume on "Alternating Current Windings" is somewhat similarly dealt with, though the subject is more comprehensive and calls for closer classification. There are accordingly seven chapters, which exhaust the subject-title thoroughly. Loop and wave windings for one, two, and three-phase working are very closely considered, and comprise the longest chapter in the book. The diagrams in this case, and in all the others for that matter, are exceptionally clear and readily comprehensible without much study. We recommend both these volumes, not only to students and winders, but to electricians in need of a good general introduction to the subject.

"'The Electrician' Electrical Trades' Directory and Handbook, 1906. The Big Blue Book."

London: The Electrician Printing and Publishing Co., Ltd., 1, 2, and 3, Salisbury Court, Fleet Street, E.C. Price 15s. nett.

The opening of another year is always signalized among electrical men by the opening of "The Big Blue Book." From our point of view this now voluminous compilation is absolutely indispensable, and to electrical engineers generally we feel it must be equally so. It reaches us again in unmistakable guise, and will be welcomed in place of its well-worn predecessor. To attempt a complete review would be impossible in our space, but we quote a few paragraphs from the editor's letter accompanying the 1906 edition :—

"Included in the contents are complete notes of the year's progress in electric traction, electric power, submarine and overland telegraphy, a very complete record of wireless telegraphic progress in 1905 both at home and abroad. In addition, the salient features of Post Office, national, and municipal telephone progress in the United Kingdom in 1905, the development of the steam turbine, the progress made in electric lamp improvements, &c., &c., are set out, and a complete summary of Parliamentary work in the past Session so far as legislation has affected the electrical industry. Full financial details relating to electrical joint-stock enterprise, and ample information relating to the financial side of every branch of the electrical industry are to be found in these pages, including a directory of directors of electrical companies, particulars of the capital authorised and issued, the last dividends paid, latest Stock Exchange quotations, all the principal officials, &c. The directory division contains the name and address of every person engaged in the electrical profession and industry throughout the United Kingdom, and a separate list of telegraphic addresses is included. Sections are devoted to the British Colonies, the Continent of Europe, Asia and Africa, Central and South America, and the United States. In addition to the usual alphabetical and classified trades divisions, these latter sections contain full and reliable particulars of all the chief officials engaged in the electrical, telegraphs, and works departments of the Governments of the world Finally, a graphic survey of the engineering and electrical equipment of all the electricity supply, electric power and electric traction undertakings of the kingdom is given in the form of five large sheet tables, the details given being very comprehensive. One of these tables is devoted to Colonial undertakings of the same character."

MANUFACTURING Progress

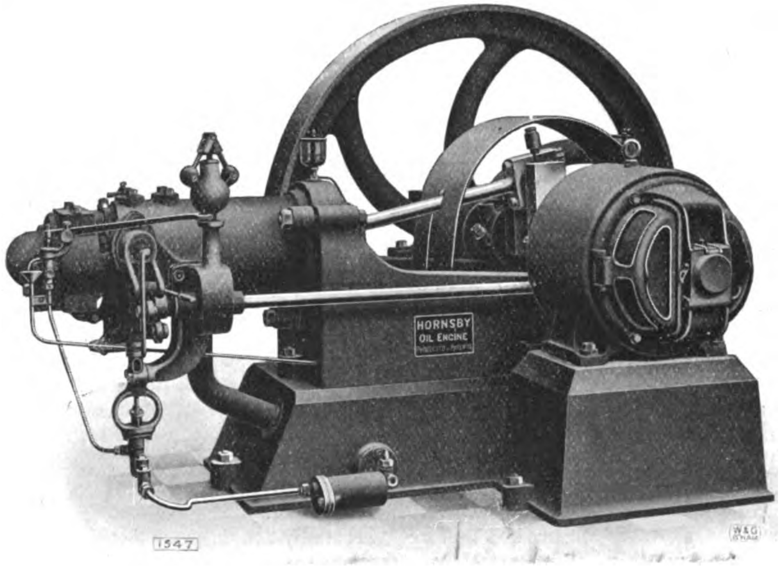
A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

"Hornsby-Stockport" Gas and Oil Engines.

SINCE the publication of our last issue we have been notified of an important development in manufacturing circles, which should be largely conducive to improvement in the design of gas and oil engines and gas suction plants. Richard Hornsby and Sons, Ltd., the old-established and now famous firm of oil engine builders, of Grantham, have secured the reputable and rapidly growing business of Messrs. J. E. H. Andrew and Co., Ltd., of Stockport, who are well known in engineering circles as makers of the "Stockport" gas engines and suction gas plants. Messrs. Hornsby have for some time had the manufacture of gas engines and suction gas plants under consideration, and after careful investigation have decided that the latest types of this apparatus, as manufactured and marketed under the name "Stockport," are the best now procurable. In future these will be known as the "Hornsby-Stockport," and we think the occasion a fitting one to refer briefly to their chief features.

The "Hornsby-Stockport" gas engine is the result of 28 years of sustained investigation and experiment. The design has recently been further improved, and whilst retaining its well-known character for strength, reliability, simplicity, and ease of management, the engine is even more economical in consumption, steadier in running, and has larger wearing surfaces, adding greatly to its durability. Every working part of the "Hornsby-Stockport" gas engine is visible and easily accessible. The greatest care is taken in the selection of the materials used in the manufacture of the engine, and the workmanship is of the highest class. Owing to the patent arrangement of valves and the perfect ignition, all small power engines can be readily started by hand. For power engines a patent self-starter is used which is most effective because there is no uncertainty in its action.

A BIRD'S-EYE VIEW OF RICHARD HORNSBY AND SONS', LTD., EXTENSIVE WORKS AT GRANTHAM.



A Useful Pattern of Hornsby Oil Engine Coupled direct to a Dynamo.

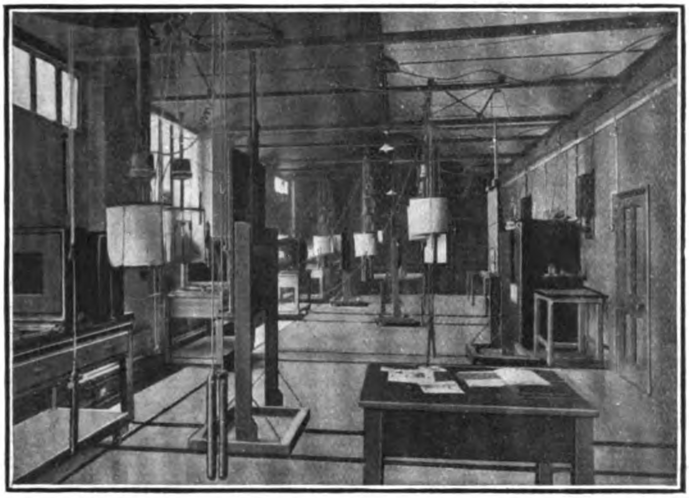
All the "Hornsby-Stockport" engines are made on the "Scavenging" principle, but without the use of long exhaust pipes. It has always been our custom so to set the valves that air is induced into the combustion chamber prior to the charge of gas and air being drawn in. This enables us to obtain the power on very low gas consumption. The tube ignition arrangement effectively controls the time of firing, and keeps the same uniform. The larger sizes of engines are fitted with a patent tube ignition timing valve bracket, and on very large engines a double-tube timing valve bracket is used. The advantage of this latter is that if a tube gives way when the engine is running the second tube can be instantly put into action, thus avoiding the stopping of the engine and the shafting it drives. The ignition bracket is so designed that there is no direct outlet to the atmosphere. This avoids the resistance which is caused by many engines discharging foul gases into the engine room through a vent hole in the firing-bracket.

The special metal ignition tubes maintain uniform and positive firing, and will last (with ordinary care) about six months. The tube makes its own joint at the bottom of the thread, and requires no asbestos or other packing.

Magneto-electric ignition is fitted to every suction gas engine, and the firm recommend it for all classes of engine, as with their patented form of electric igniter the ignition is more positive, starting is made easier and more reliable, and as there is no external flame, as with tube ignition, the engine is safer. Duplicate sparking plugs can be fitted to the large engine if required, and the plug can be easily removed for inspection and cleaning. From tests made by independent experts on behalf of customers we understand it has been found that with large engines the consumption is at the rate of about 12 cubic feet of gas per brake h.p. per hour under full load, varying to 20 cubic feet in the smallest size with town gas of 700 B.T.U. per cubic foot.

The suction gas engines are so constructed that they can be worked with either town gas, producer gas under pressure, or suction producer gas. They are of special value to anyone considering gas engine power, as the change can be made from one class of gas to another at a minimum of expense.

The "Hornsby-Stockport" suction gas plants are extremely cheap, simple, occupy little space, require little attention, cost practically nothing in repairs, can be erected in any building, can be quickly started, give off no smoke after engine is started, and there is no danger either of explosion or from the gases. They are absolutely reliable. The consumption of coke is about 1lb. per b.h.p. per hour, and the consumption of



THE ARC LAMPS IN CARL HENTSCHEL COPYING STUDIOS.

anthracite coal about ¾lb. per b.h.p. per hour; 10 to 20 B.H.P. is obtained at the cost of one penny per hour for fuel.

With works at Grantham and Stockport, Messrs. Hornsby will now be able to touch a wider field for business and be in a position to make deliveries with a minimum of delay. The development of the business which will thereby be made possible should do much to enhance the output of the concern, and still further spread the influence of its sales organization, and the name “Hornsby-Stockport’ will now be regarded as representing the pinnacle of perfection in the design and manufacture of gas engines and gas suction plants, and attain a degree of notoriety excelled only by that of the Hornsby oil engine.

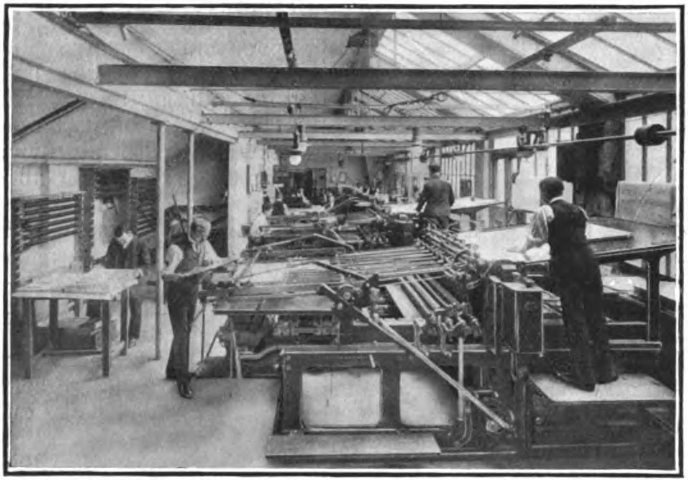
Engraver's Work for Electrical Engineers.

The Business of Carl Hentschel, Ltd.

THE growth of the electrical industry has occasioned the introduction of new methods in business campaigning which require a complete change of front in the conduct of affairs. In the organization of a sales department, the art of engraver and printer is now drawn upon, and to an extent which was at one time impossible owing to the lack of experience of its exponents in efficiently and promptly supplying the needs of the engineer. It was then the turn of the engraver and printer to receive patiently the instructions tendered them. Now the teacher may sit at the feet of his former disciples to hear their counsel upon what is best for him.

To put it briefly, the science and practice of engraving is on a level with that of electrical engineering, economically and efficiently considered, and the wants of the latter in respect of the former can be readily and effectively met. But like electrical work, engraving must be undertaken on broadly organized lines to ensure the maximum of efficiency with a minimum of delay. Judged from this standard, the firm of Carl Hentschel, Ltd. (1906), is of interest to electrical engineers and manufacturers as representing that type of organization which alone is a guarantee in itself of sound work, well and quickly done. We include in this section this month some views in the studios of the company, as indicative of the high standard not only aimed at, but actually attained in the work produced.

EXPERT ARTISTS AND RE-TOUCHERS AT WORK USING THE AEROGRAPH IN CARL HENTSCHEL STUDIOS.



Proofing Blocks on Large Flat-bed Electrically-driven Printing Presses, Carl Hentschel Studios.

When a manufacturer commences to think of the production of some high-class piece of literature to describe and adequately illustrate a particular product of his works, he seeks to procure the best, and only the best, that engraver and printer can put into his hands—that is if he is wise in his generation. We need not enter into the technicalities involved between the copying of the subject and its emergence as a block, but we can draw attention to the detail work put into a crude print, whereby its nakedness is made to give place to the attractive and forceful clothing with which the artist's brush covers it. The retouching of a raw photograph is an art in itself, and can only be successfully carried out with, firstly, the right men, and secondly, and more important, the right apparatus. Here it is that organization and concentration enter and fill the gap left by isolated misdirected effort. In the Hentschel studios are a dozen or more expert retouchers who can at short notice transform the baldest subject into copy fit for the clear and distinctive reproduction.

In the preparation of successful business-getting literature the initial services of the artist are all-important and must on no account be overlooked, but equally contributory to this result are the subsequent details whereby the process plate is gradually developed up to the finished state. Here again organization and management play their part in assembling the best possible talent and skill, equipping it with modern efficient apparatus and guiding, and instilling into it the attainment of those high standards which stamp the product with the hall mark of quality and merit. It is combination of effort which has given us present-day efficiency and despatch, and these are indispensable in the engraving world. To the man in the market for high-class trade literature the spectacle of a splendidly organized and abundantly fitted engraving establishment should appeal, because to him it spells business, and big business. He can set his mind at rest that the "pictorial end" of the work will be in safe hands and all that research and application can do will be embodied in his appeal to the customers he hopes to secure.

An undertaking such as that of Carl Hentschel, Ltd., backed by twenty-five years' experience and now accoutred with the latest and best from the stores of chemistry, electricity, mechanics, and optics, is pre-eminently suited to undertake engraver's work from the elaborate "colourtype" to the simple line block, with that depth and breadth in the result which even engineers with no pretentions to the artistic have learned to expect in reproductions of their handiwork. We hope that, with its newest organization, Carl Hentschel, Ltd., will meet with a patronage from the electrical section of engineering which the enterprise of its founder and managing director deserves, and that the reputation built up for British photo process work by that indefatigable worker may be materially enhanced by his connection with electrical journalism and literature. The illustrations of both The Electrical Magazine and Popular Electricity testify to the admirable results which the Hentschel processes give in skilled hands, even with the most complex technical subjects.

The electrical equipment of the company's establishments is very complete, full advantage being taken of the latest plant for the purpose. The installation includes suction gas plant (by the Industrial Engineering Co.) and modern arc lamps in the copying departments. Printing presses also are equipped with motor drive of the most recent design.

Some Important Tramway Contracts.

J. G. White & Co., Ltd.

In the field of tramway construction Messrs. J. G. White & Co., Ltd., occupy a unique position in that they have carried out some very extensive contracts for electric tramways. We have received from the firm a complete list of the work they have completed and of the contracts in hand, and a few of the larger items contain instructive figures. Belfast Corporation Tramways, recently finished, head the list with a total value of £535,000, the L.C.C. being next in importance at £468,200. This latter is for construction work completed, but a quantity of work is now in hand which makes the total for this public body £796,200, or over three-quarters of a million, a series of contracts which is something to boast of. The complete construction of the Amsterdam-Haarlem Electric Railway was another important piece of work with a contract price of £300,000, and is itself exceeded by the Auckland (N.Z.) tramways, valued at £375,000. The total of thirty-five completed contracts is £3,135,200, or an amount which would capitalize a London power company. The contracts in hand are sufficiently interesting for us to append a list.

List of Contracts in Progress.

	£
Bombay Electric Supply and Tramways Co. (Tramways)	200,000
Ecuador	200,000
London County Council, Contract "J"	187,000
London County Council, Stamford Hill, Contract "L"	141,000
London United Tramways	165,000
Montevideo (Uruguay) Tramways (complete construction)	400,000
Mansfield and District Light Railways (Extension)	5,000
North Melbourne Tramways	207,000
Wigan (Lancs.) Corporation Electric Tramways	30,000
Rural Tramways, Buenos Aires	250,000
Para Tramways (Brazil), complete reconstruction	400,000
Miscellaneous Engineering	30,000
	£2,215,000

General Notes.

"Faraday House" Old Students' Association.

The second annual dinner of the Old Students' Association was held at the Florence Restaurant on Friday, the 9th inst., when about 100 members and friends met to support the President, Mr. C. D. Taite, M.I.E.E., Borough Electrical Engineer of Salford, who was in the chair. Among those present were Mr Robert Hammond, M.I.E.E. (the Patron), Mr. Hugh Erat Harrison, B.Sc.,M.I.E.E. (the Principal), Mr. Hugo Hirst, M.I.E.E., Mr. G. W. Partridge, M.I.E.E., Mr. C. P. Sparks, M.I.E.E., Mr. S. Dobson, M.I.E.E., Mr. J. S. Highfield, M.I.E.E., Mr. H. W. Kolle, M.I.E.E., and Mr. A. H. Walton, M.I.E.E. A novel departure was made, no speeches being allowed, and only toasts given; the result was a decided increase in the merriment incidental to such an occasion. The dinner was followed by a musical programme, which was kept going until a late hour. The menus were illustrated with views of the Hammond College and the Old and New Faraday House, and the committee are to be congratulated upon a most successful evening.

A. P. Lundberg and Sons.

The honour of a Royal Warrant has been granted to A. P. Lundberg & Sons, Pioneer Electrical Works, 477 to 487, Liverpool Road, Islington, N., as suppliers of electrical accessories to His Majesty King Edward VII. The name of the firm will in future be known as A. P. Lundberg & Sons, instead of A. P. Lundberg as heretofore. This change, however, will not affect the management or proprietorship, Gus. C. and A. P. Lundberg having been associated with the business for the past 23 years. Our congratulations to the firm on the conference of this honour.

Ferranti Limited.

Ferranti Limited have recently received the following orders for switchgear, etc.:—l.t. a.c. three-phase switchboard for Luipaards Vlei Estate Gold Mining Co., Ltd.; c.c. and a.c. three-phase switchgear and transformers for h.t. transmission scheme in Japan; c.c. substation switchgear for Glasgow Corporation; c.c. battery and booster switchgear for Pontypridd U.D.C.; h.t. a.c. three-phase and l.t. d.c. switchgear for abroad; e.h.t. main and substation and l.t. a.c. substation switchboards for the Dublin Corporation; extensions to h.t. switchgear at Wimbledon.

New Catalogues

Automatic Circuit Breakers.—THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby. Pamphlet No. 191 (which supersedes No. 162) describes a number of interesting types of circuit breakers. They are suitable for alternating-current and direct-current circuits, have capacities ranging from 15—10,000 amps., and the maximum operating voltage is 650. All are of the carbon break pattern with laminated contacts.

Arc Lamp Gear.—NORTH-WESTERN ELECTRICAL APPLIANCE CO., Cathcart, Glasgow. An illustrated booklet describes the arc lamp lowering gear of this firm, which admits of a great saving in the cost of attending to street arc lamps. The makers assume that two men trim fifty lamps per day and the cost per week for their wages will be £2 8s.; this is assuming that a ladder tower is used. With the lowering gear only one man is needed, whose wages will be 18s., or a saving of 30s. per lamp per year. By this method the cost of the lowering gear is saved in two years. The arrangement is very compact, and interested engineers should write for particulars.

Machine Stoker Progress.—The electrical department of that enterprising body the Shoreditch Borough Council has placed an order with the Stirling Boiler Co. which stipulates for the supply by MESSRS. ED. BENNIS & CO., LTD., Little Hulton, Bolton, of eight patent chain grate stokers, Bennis-Miller-Bennet type, fitted with the ingenious "Bennis" patent light load damper, the necessary shafting, gearing and accessories. The stokers are to be used in connection with both Stirling and Babcock & Wilcox water-tube boilers. The various economic points of vantage which characterise the new chain grate have been well described in various sections of the technical press.

Oil Engines.—RICHARD HORNSBY & SONS, LTD., Grantham. "The Hornsby Oil Engine" is the title of a handsome and bulky volume issued by this well-known concern. It comprises 100 pages of matter and illustrations describing the famous oil engine now universally associated with the name "Hornsby." That cognomen seems in fact to be synonymous with the term oil engine, so successful has the design been. The book itself is divided into three sections, devoted respectively to a description of the engine and official tests, types and sizes of engine, and the engine at work. The illustrations and typography are of the best, and no expense has been spared to make the booklet attractive. It should be in the hands of all those contemplating, especially, the electric lighting of country houses, or places remote from electricity supply.

Various Publications.—A. E. G., Foreign Department, 125, Charing Cross Road, W.C. From this company comes a batch of lists, ready punched for dropping into the neat file handed to us many months ago. They are notched for ready thumb reference, and deal with petrol electric sets, arc lamps (E list, No. 9), one, two, and three-phase induction motors, ventilators (E list, No. 3), incandescent lamps, flexible wires and accessories. The petrol sets are very neat and compact, and comprise a four-cylinder engine direct-connected to a small dynamo. The circulating water is cooled by a fan playing on a large honeycomb radiator attached to the engine bed. The sets are made to run on petrol, alcohol, or petroleum, and range in output from 1.34 to 3.9kw. with high-speed sets, and from 5 to 13kw. with slow-speed units. The alternating-current induction motors are of small size, and range from ½ to 5h.p. capacity; they can be supplied with plain rotors or slip rings.

Steam Turbines.—MATHER & PLATT LTD., Manchester. To their already substantial list of uniform booklets we have now to add another of Mather & Platt's publications, the new arrival dealing with steam turbines. Its opening pages are devoted to a comparison of turbine types, reaction and impulse — and decision is given in favour of the latter. This introduces the subject of the booklet—the Zoelly turbines, which is a multi-stage impulse machine. Space is then devoted to a description of this turbine, which is followed by particulars of tests, and a list of the machines now in use or under construction. The total horse-power is stated as 72,430. We give illustrations of the machine on pages 166-7 of this issue. A useful enquiry slip with suggestions to interested parties accompanies the pamphlet, and should result in negotiations leading to business.

Ceiling Rose.—THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., send us a leaflet describing their "Wind-up" Ceiling Rose, which is very ingenious and is to be recommended. It offers an improved means of raising and lowering light electrical fittings, whereby the movable fitting can be retained in any desired position without the use of balance weights. In other devices of this description placed upon the market from time to time, it has been necessary to have a fitting or fittings of a specified weight sufficient to balance the strength of the spring drum. The "Wind-up" Ceiling Rose can employ fittings of varying weights with equal effect, as it is not upon the weight of the fitting that the working of the article depends, but upon the band brake arrangement, which proves very effective in practice. Unlike other types the entire mechanism is enclosed in porcelain, and perfect electrical contact is made. It is very easily wired, strong, and well finished.

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. V. NO. 4. (28th Issue.) LONDON. APRIL 24, 1906.

The World's Electric Progress.

The Great Reunion in June.

FOLLOWING up our announcement last month of the gathering of foreign electrical engineers in this country in June next, we draw the attention of our home readers to the importance of this reunion to British electrical interests generally. There is no record in our own history of electrical work, of the congregation, at one time and place, of the most eminent electrical men of America and the Continent in Great Britain, and this circumstance in itself raises the standard of the meeting above that of the now stereotyped annual convention. The idea of the gathering pays high tribute to our great men of the past whose researches and experiment gave birth to the age of practical electricity, and made possible subsequent dazzling achievements in other lands. We need hardly state that every effort should be made to make the visitors welcome, while they should be bidden "God speed" with tangible evidence of our enterprise and ability in the arts which they have done so much to further. For our part, we of THE ELECTRICAL MAGAZINE shall produce a record of British electrical work which will be embodied in an International number, covering in a comprehensive manner the broad field of electrical manufacture and supply in these islands. This exceptional issue, which we purpose publishing on the opening day of the official visit, will constitute our tribute to the importance of the occasion. We have mapped out an ambitious programme, our intention being to produce a number excelling anything hitherto issued from our offices. We hope, in fact, to present our American and Continental friends with a production that will rank as a permanent and interesting record and souvenir of the auspicious event. We shall subsequently announce fuller details, and meantime we take this opportunity of inviting the co-operation of manufacturers, central station engineers, and others interested, in supplying data and illustrations for the number in question. Incidentally we may say that a big sale is assured, so that early application should be made for copies to avoid disappointment.

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A Society of Illuminating Engineers.

IN our Lighting Section this month will be found the first portion of an interesting article by Mr. L. Gaster, pointing to the immediate need, not only for qualified illuminating engineers, but also for an association to further the science of illumination. It cannot be doubted that the time is now ripe for a concentration of effort to this desirable end, and we specially direct the attention of our readers to Mr. Gaster's admirable appeal for support. The chief reason why this movement should be fostered and carried to fruition is its tendency to focus the interests of electrical and gas engineers on a common object, namely, the provision of efficient illumination apart from commercial rivalry. To achieve this object would be worth the expenditure of tireless effort, and if it can be attained the thanks of the industry as a whole will be due to those directly or indirectly responsible for the result. A Society of Illuminating Engineers would admit the exponents of lighting by electricity, gas, and oil; in fact, an effort would be made to give men a knowledge of all three without prejudice to either, so that an "illuminating engineer" would be qualified to advise on the installation of one and all such lighting methods. If this idea can be brought home it will form a class of experts whose advice can be sought without fear of prejudice in favour of this light or that. Obviously here is an opening for the young men in the profession, men who on leaving college find few new fields for the exploitation of their energies, and who frequently accept uncongenial and unprofitable berths. In the last part of his article, to be published next month, Mr. Gaster makes a direct appeal for help, which, however, we will not anticipate, but commend the subject generally to the notice of our readers.

❧

Water-power in the Scottish Highlands.

We have too often had occasion to bemoan the dearth of water-power developments in this country compared with the abundant facilities enjoyed by other countries. From the article which we publish this month from the pen of Mr. W. B. Esson, it will be seen that in certain cases advantage can be taken of mountain lakes to operate small plants, which in turn can supply distant localities by overhead transmission lines. The Strathpeffer installation is decidedly novel among installations of the kind in these islands, and we devote special space to it this month, being convinced that readers will take interest in the description. The use of overhead wires has contributed largely to the success of the scheme, and made it possible to take advantage of long-distance transmission. We may yet have to record the utilisation of water in some other part of the country at present undeveloped and innocent of electric power.

❧

One-phase Railways.

Strange as it may seem, British electrical engineers exploited one-phase systems, and partially dropped them for polyphase methods developed abroad. Now, it would appear that under the dictates of foreign electrical men, who have improved the one-phase railway motor to a point of commercial utility, they will again return to their old love. Certain it is that very rapid strides are being made with the one-phase railway movement, and some striking results are being achieved. In this issue we give details of the once nebulous and much criticized locomotives for the New York, New Haven, and Hartford Railway, and these are novel enough to meet the wishes of the most ardent hunter after the uncommon. By novel we mean in respect of the manner

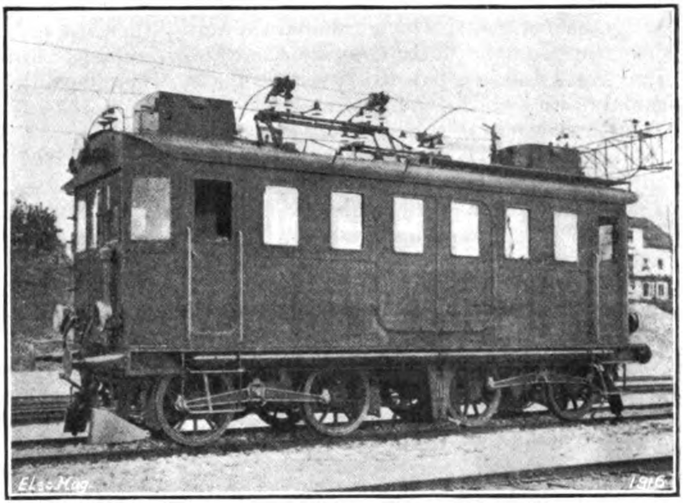
Sub-station at the end of Transmission Line of Scottish Water-power Plant.

of application of the one-phase motors to the locomotive trucks. The suspension is, we understand, not new, though it certainly is to one-phase working, and the same may be said of the drive. At first blush the method appears costly and complicated, but from reports the locomotive has had exhaustive trials, and no serious troubles have been encountered. The forced ventilation is likely to meet with unfavourable criticism as an unnecessary adjunct to the motor system and so much extra weight. It is hard to believe that its application to the motors is due merely to the existence on board of air-blast transformers calling for a motor-operated fan. Comparing the several systems advocated, we are disposed towards the Ward-Leonard as dealing with the problem in the most satisfactory way. The flexibility of control and the simplicity of the parts give it claims which cannot justly be advanced for other systems.

* * *

Electric Winding.

It is not often we find great interest taken in the papers read before the parent body of the Institution of Electrical Engineers, but the opposite was certainly the case with the Manchester paper of Mr. W. C. Mountain on the subject of electric winding for collieries. Singularly enough, this paper was run in parallel with one by Mr. C. P. Sparks, describing the Powell Duffryn colliery equipment, but it absorbed all the load and maintained it well until the discussion was shut down. As our readers are already aware, Mr. Mountain set out to persuade his confreres of the follies of electric winding and backed his views with tables of figures which, in themselves, seemed plausible enough to meet his case. But this negative policy did not suit the audience, and the discussion, prolonged over three meetings, brought up engineers willing enough to dispute Mr. Mountain's figures. Briefly, it may be said that the opinion held was that Mr. Mountain had lifted electric winding "out of its context" so to speak, and pulled it to pieces without regard to all the factors bearing upon it. Although he replied fluently enough to the criticism heaped upon his figures, he could not fairly repel the attack, and, if his opponents did not leave him for dead, they certainly succeeded in breaking down his defence and robbing him of his weapons. Whether the electric winder is superior to steam is a matter which will, however, be settled by no "figure flipping" on the floor of the Institution. The time is not yet to condemn electric winding out of hand, nor can it for the present be generally advocated in place of its rival. It must suffice for the moment that electrical men are not daunted by the problem before them, nor will they be scared off by premature warnings of dangers ahead, which have no existence save in the minds of those taking an alarmist view of a decidedly interesting situation.



WARD-LEONARD ONE PHASE LOCOMOTIVE AS USED ON THE SEEBACH LINE IN SWITZERLAND.

* * *

The Late Carl Heinrich von Siemens.

WE regret to record the death quite recently of Carl Heinrich von Siemens, chairman of Siemens Brothers and Co., Ltd., at Mentone. He was the sixth son in a family of eleven sons and three daughters, and for the greater part of his life he co-operated with his brothers, Ernst, Werner, William, and Friedrich. With the first-named two he was instrumental in the development of the firms of Siemens Brothers, and Siemens & Halske, and of the various undertakings with which the name of Siemens is associated. As an inventor his name is not so well known as those of his brothers, but he was a man of great energy and perseverance, and made a name as a capable administrator and organiser. After the death of his father he became the assistant, in the firm of Siemens & Halske, of his eldest brother, the late Dr. Werner von Siemens, whom he helped to lay the first underground wires. In 1852 the Berlin firm was entrusted by the Russian Government with important telegraph contracts, which resulted in Carl being appointed to take complete charge of the firm's interests in Russia, and it was mainly owing to his energy and ability that the Russian business grew so rapidly and to such considerable proportions. He worked in conjunction with his brother William in London for eleven years, during which period the Woolwich works were gradually enlarged and a gutta-percha factory established there. Amongst other interests he took an active part in the laying of submarine cables. In this connection it is interesting to record that he was the first who succeeded in raising from the bed of the Atlantic a broken submarine cable. When Dr. Werner von Siemens died in 1892, Mr. Carl Heinrich von Siemens was called to Berlin to take the leadership of the firm of Siemens & Halske, and in that year also he was elected to the chairmanship of Siemens Brothers and Co., Limited, which position, as stated, he held till his death. Mr. Carl Heinrich von Siemens' character may best be summed up by quoting from the "Personal Recollections of Werner von Siemens"—"I should call the next brother, Charles, the most normally constituted of us all. He was always to be depended upon, faithful and conscientious, a good pupil, an affectionate, attached brother. His clear eye and generally cultivated understanding made him an excellent man of business, and, with his large technical knowledge and an excellent tact, an admirable conductor of business undertakings. Charles was the true connecting link between us four brothers, who differed indeed radically from one another but were bound together for life-long common work by all-subduing fraternal love."

Britain's Electrical Industry.

A DIP into the history of electrical work in this country fills the reader with wonder that there is any electrical industry at the present day. Circumscribed with legislative restrictions of the most stringent character the marvel is that the new industry could get up any movement towards a higher and stronger position among its rivals. Mr. E. Garcke, in a series of excellent articles to the *Times* Engineering Supplement on the British Electrical Industry, makes a striking comparison between the state of electricity supply undertakings in 1895 and 1905, this branch being fairly representative of the whole. In 1895 there were thirty-eight companies at work, and their capital expenditure amounted to six millions; in the same year thirty-three municipalities had borrowed nearly two millions for electric lighting works. Last year, or ten years later, 187 companies were in the field with a capital outlay of some thirty-two millions, and 277 municipalities with loans amounting to nearly thirty-six millions. It comes as a surprise to hear that in 1905 the average capital expenditure per kilowatt installed over the United Kingdom was not any lower than £81. The differences in the working expenses are little short of remarkable, and we tabulate them as given by Mr. Garcke:

	1895.	1905.
Generation and distribution	2.81d.	.99d.
Rents, rates, and taxes . .	.35d.	.14d.
Management	.81d.	.18d.
Sundries	.10d.	.02d.

Commenting on these results, Mr. Garcke refers to an incident which is best presented in his own words: "Colonel Crompton, in a paper which he submitted to the Institution in 1894, prophesied that the day would come when, with an output of five million units and best coal at 20s. per ton, the cost of production and distribution, including rent, rates, and management, would work out at 1.32d. per unit sold. The estimate was received with some scepticism, but from the figure given above as the total working expenses of 1905 — not of one selected undertaking, but as the average of all the undertakings in the country—it will be seen that Colonel Crompton's prophecy has been realised to the second place of decimals, a remarkable confirmation which is certainly entitled to be considered as more than a coincidence."

POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

* * *

Electric Light and Power in the Highlands.

(Special Article.)

By W. B. ESSON, M.Inst.C.E.

In the Highlands of Scotland, amidst scenery of romantic grandeur, are to be found the northernmost towns in these isles lighted by electricity. Journeying beyond Inverness, after skirting the wild coast of the Beauly Firth, we come upon the town of Dingwall, and some few miles further west upon the fashionable Strathpeffer Spa. The latter lies in a valley surrounded by heather-clad hills, and its white villas and gardens dotted here and there on the rising ground remind one forcibly of a scene in Switzerland. The medicinal virtues of the springs and the charming situation of the Spa have gained for it the name of the Harrogate of the North.

It is to the enterprise of Major E. W. Blunt, R.A., the husband of the Countess of Cromartie, whose estates include Dingwall and Strathpeffer, that these towns owe their electric lighting. In 1902 contracts were placed for the carrying out of a scheme which, though of small proportions, is in all essential features similar to many of the hydro-electric undertakings on the Continent of which we have from time to time heard so much. The scheme embraced the construction of a dam and reservoir to conserve the water of a stream—Allt Gleann Sgathaich—running down Ben Wyvis, the erection and equipment of a power-house about a mile further on, and the pipes leading thereto, overhead lines into Strathpeffer and Dingwall, transforming houses at these towns and at other places where power and light were required, and a complete system of underground mains for the lighting of the towns. The general lines on which the work was to be carried out were specified by Mr. George F. Deacon, Major Blunt's engineer, and it fell to the lot of the writer, as technical adviser to Messrs. Johnson and Phillips, who were the contractors for everything but the pipe line, to handle the electrical portion of the undertaking, and to design all the machinery and apparatus appertaining thereto.

A view of the reservoir is given in Fig. 1. This is dug out of the solid peat, and from it a single pipe line runs for about a mile to the power-house. The pipe lengths are of welded steel, 13in. diameter and ¼in. thick, and are coated inside and outside with a special rust-preventing composition. They are entirely buried in the ground at a depth of from 2ft. to 8ft., according to the contour of the route, and are provided with flanges jointed by means of a thin rubber ring according to a method devised by Messrs. Piggott, of Birmingham, who supplied them. A large grid prevents bits of trees, leaves, or other objectionable materials from entering the pipe at the reservoir. At the power-house a main sluice valve is fixed just outside the generating station, while a relief valve prevents damage being done to the pipe in the event of shock due to sudden fluctuation in the load. At the power-house the head of water obtained is 600ft., corresponding to a pressure of 260lb. per square inch, and all the pipes were tested at the makers' works to double this pressure.

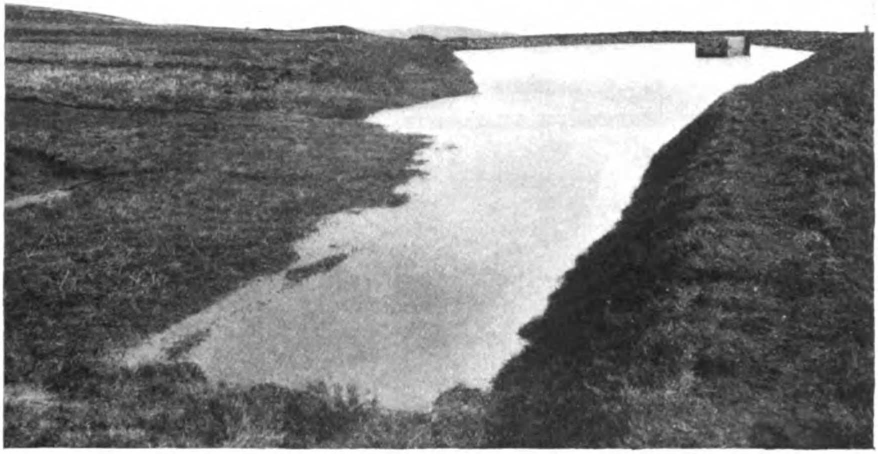


Fig. 1. View of Reservoir.

The power-house is situated in a wild region close to the frowning Raven's Rock, and is passed by the Dingwall and Skye branch of the Highland Railway. The exterior of the power-house is shown in Fig. 2, the cottage adjoining on the left being in the occupation of the power-house attendant. Granite stones shaped from the boulders lying in the neighbourhood served to build its walls. On the right hand will be seen the terminal pole of the transmission line, the conductors being carried down the

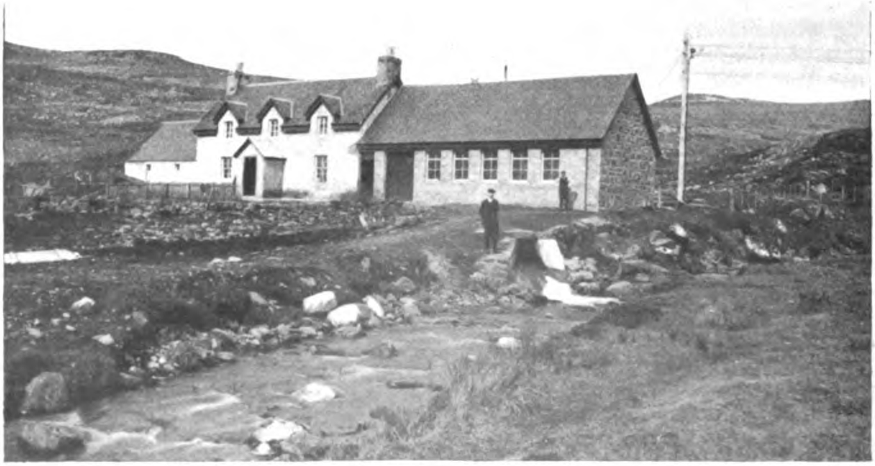


Fig. 2. Power-house, Transmission Line, and Engineer's House.

same in wrought-iron pipes dipping underground and rising on to the switchboard inside the power-house.

The generating plant is shown in Fig. 3, and consists of two three-phase 100kw. alternators, each coupled to a Pelton wheel and furnished with its own exciter. These sets run at a speed of 500 revolutions per minute, and generate current at a normal pressure of 3000 volts, the frequency being 50 cycles per second. It may be mentioned that the specification called for a single-phase system, but on the writer's advice three-phase was decided upon, a fortunate circumstance in view of the power work that has come on the mains. As water is none too plentiful, every means had to be taken to economise it; accordingly, for the maximum water available at the power-house as much electric energy as possible had to be delivered at Strathpeffer and Dingwall, and when running under full load water had to be saved. The former condition was met by making the efficiency of all the plant high, and the latter condition by adopting a method of governing the Pelton wheels, whereby the water used was roughly proportional to the work being done. Anything in the shape of a deflecting nozzle would have been useless in the circumstances, so the governing is done by the insertion or withdrawal of a spear-shaped rod into the tapered nozzle from which the jet issues on to the wheel. The orifice is by this means enlarged or constricted, the spear being attached to a piston working in a hydraulic cylinder, the motion of which to open or close the nozzle is controlled by a hydraulic relay actuated by the governor. In this way the speed is kept well within good regulation limits and water is not wasted. The nozzle normally in use is 1¾in. diameter, but both Pelton wheel and alternator will give an overload of 25 per cent. with a larger nozzle fitted. The generator and wheel are better seen in Fig. 4, which is from a photograph taken at the makers' works before the machinery was sent forward. Each set has five bearings, but these are so carefully lined up that when the water is shut off from the wheel it will continue to run by itself for thirty minutes.

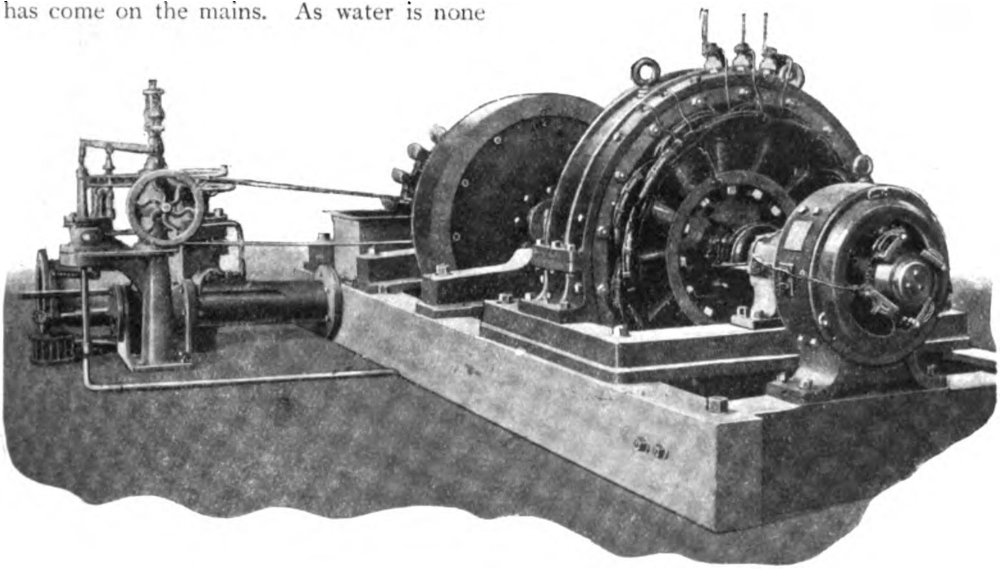


Fig. 4. 100kw. Turbo-unit, with Exciter and Governor.

An interesting feature of the installation is that the whole of the control, both as regards the governing of the Pelton wheels and the maintaining of the customer's pressure independent of variations in load, is entirely automatic. To put it tersely, the attendant in the power-house turns on the water and lets the plant "rip," no attention being required beyond an occasional oiling. The regulators, one for each generator, which effect this are supplementary to the usual hand rheostats and are of comparatively simple construction. The problem, it will be seen, is to automatically raise the

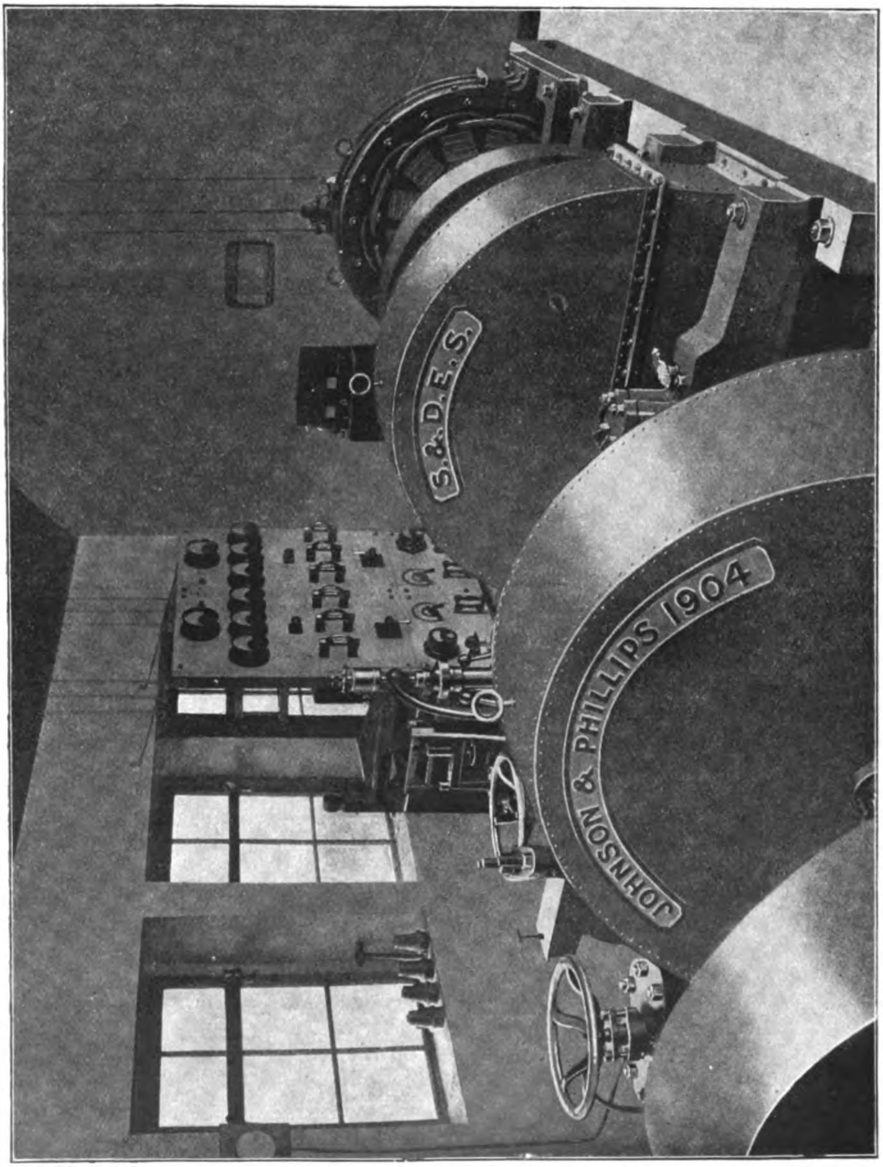


FIG. 3. VIEW OF ENGINE-ROOM AND SWITCHBOARD.

pressure at the generator bus-bars as the load increases, in order, first, to compensate for extra drop of pressure in the low-tension feeders in Strathpeffer and Dingwall, and, second, to compensate for the extra drop of pressure in the overhead lines. In round figures the bus-bar pressure has to be 12 per cent. higher at full load than at no load, and the regulator has to automatically adjust the resistance in the alternator field so that this condition is fulfilled. The exciting current is varied by the action of two solenoids, which, by directing a horizontal iron plunger to the right or left, puts in or takes out resistance in the field circuit. When adjustment is required, a sensitive relay closes a circuit from the exciter through the right or left solenoid, thus determining, according to whether resistance has to be added or subtracted from the field circuit, the direction of the plunger's movement. The relay, when the magnetic field due to the current in its coils becomes stronger, causes resistance to to be added to the field circuit, or when the field becomes weaker causes resistance to be removed from it. This relay coil is fed from the secondary of a differential transformer on which there are two primaries, one excited from the terminals of an alternator coil, and the other excited in the opposite direction by a few turns of one of the three line wires leaving the power-house. It will be seen that if the voltage is to be constant on the secondary, and consequently on the coil of the relay, the pressure of the alternator must rise to correspond with the amount of current flowing through the line, since the secondary voltage is due to the combined influence of the two primaries. Whenever, therefore, the pressure is too low or too high to correspond with the current, the relay voltage is altered, and the resistance is varied as described until on the bus-bars a pressure proper to the line current is obtained.

The switchboard calls for no special remark. There are mounted on it the necessary high-tension switches and fuses, ammeters, voltmeters, and synchronising apparatus. A three-core paper insulated, lead-covered cable enclosed in 2½in. wrought-iron pipe takes the current to the top of the terminal pole, details of which are shown in Fig. 5, and from thence three No. 6 s.w.g. bare copper wires carry the current at a pressure of 3000 volts across country to Strathpeffer and Dingwall. The wires are placed at the three points of an equilateral triangle having a side of 22in., one of the insulators being carried on the top of the pole, and the other two on a 3in. by 3in. oak cross arm underneath. Double petticoat insulators are used, and three feet below the power line a telephone circuit is run on ordinary swan-neck insulators to establish communication between the power-house and the sub-stations. As will be seen from Fig. 5, horn lightning arresters are employed, and, wherever the wire goes underground, choke coils in conjunction with them. These arresters are fixed along the line at intervals of one mile, and the grounded side is connected to a copper plate buried in coke at a depth of at least six feet under the ground.

The poles are spaced normally thirty-five to the mile, and are of larch felled on the estate, 5in. diameter at the top, and about 10in. diameter at the bottom. For the most part they are 30ft. long, buried 5ft. in the ground, but for special positions the length is increased to 40ft. The line to Strathpeffer is three miles long, and the line to Dingwall six and a quarter miles, the Dingwall line branching off from the other one mile outside Strathpeffer. In Fig. 6 will be seen the pole line reaching away to the power-house at the Raven's Rock, while Fig. 7 shows the pole on which the junction of the Strathpeffer and Dingwall lines is made. Fig. 8 shows a crossing over the Dingwall and Skye Railway. Here the overhead wires have to join on to a cable, which is taken down the side of the pole in wrought-iron pipe, carried underground, and brought up the pole on the opposite side of the railway. These two poles are fitted with lightning arresters and choke coils, just like the terminal poles at the power-house. It is

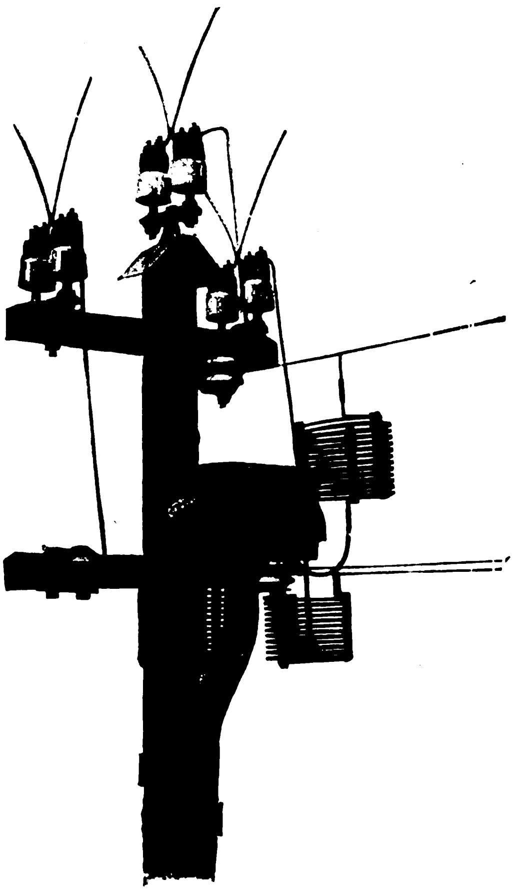


Fig. 5. Terminal Pole with Link Insulators, Choke Coils, and Arresters.

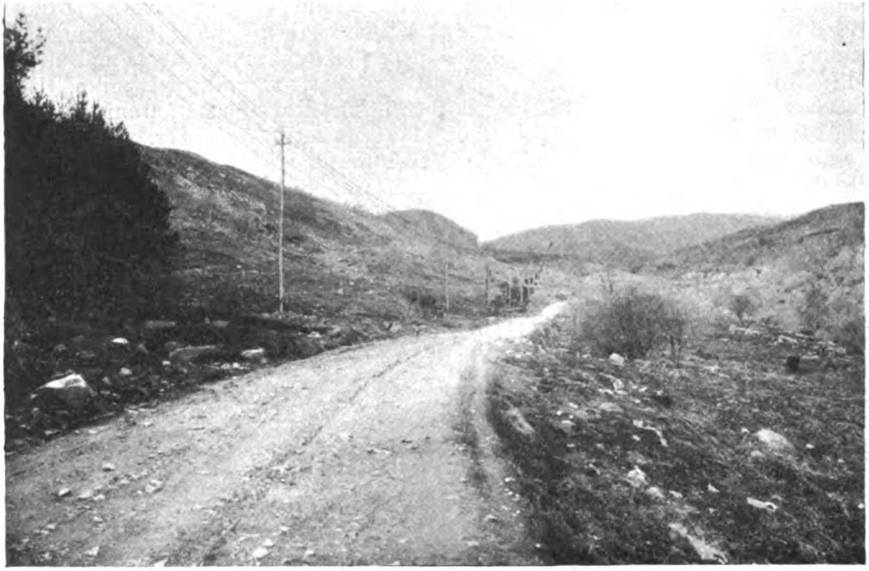


FIG. 6. TRANSMISSION LINE ON SIDE OF PUBLIC ROAD.

interesting to note that the line to Dingwall crosses the main county road three times, the Board of Trade offering no objection, as proper measures were taken in each case for the protection of the public. One of these crossings, just outside Dingwall, where the line spans the road parallel to the railway and at a level crossing, is shown [in Fig. 9. It will be seen that on the poles on opposite sides of the road a longer cross-arm is fixed above the cross-arm carrying two of the power wires. Galvanised steel wires are attached to the extremities of these arms, and are stretched from one side of the road

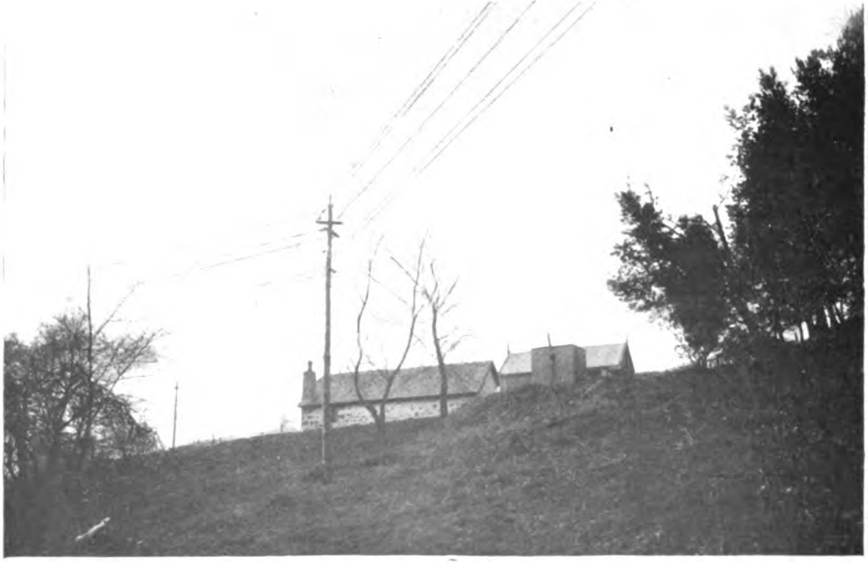


FIG. 7. JUNCTION POLE ON THE TRANSMISSION LINE

to the other, these with a third wire underneath attached to the pole itself and similarly stretched forming the three points of an inverted equilateral triangle. These three wires support half hoops of galvanised steel wire bound on to them about 3ft. apart, the whole forming a sort of hammock stretched underneath the power line from one side of the road to the other. The hammock is 65ft. long, this being the distance between the poles, and the latter stand 35ft. out of the ground. As the hammock projects 12in. beyond the power wires on each side, in the event of one of the latter breaking it would certainly be caught by the former. But such an event has not yet occurred, nor is it likely to occur. Notwithstanding the severe storms to which the lines have been subjected since their erection, there has never been a single mishap due to a wire breaking or a pole being blown down.

At one of the poles near the junction of the Strathpeffer and Dingwall lines a tapping is made to light Castle Leod, the seat of the Countess of Cromartie. For this purpose a three-phase transformer is enclosed in a wooden lock-up hutch at the base of the pole, the high-pressure conductors being brought down the pole to this in a pipe. Horn arresters protect the transformer and its connections from damage by lightning. From the low-tension side of the transformer an underground main, laid in pipes, takes the current to the castle. The high-pressure line to Dingwall is also tapped to supply power to the Cromartie estate saw-mill at Auchterneed. Here a 20h.p. three-phase induction motor is installed to drive a circular saw, being fed from the low-pressure side of a three-phase transformer. This motor replaced an old portable engine, and the working of the mill is all that can be desired, 40b.h.p. being frequently called for.

The overhead line to Strathpeffer ends just outside the town, the current being led to the transformer-house by a three-core, paper-insulated, lead-covered cable. This is drawn into 2½in. wrought-iron pipe, which is laid underground, and provided with a draw-in box about every 80 yards. The overhead line to Dingwall runs right on to the transformer-house, of which an exterior view with the terminal pole outside the building is shown on page 218. The transformer-houses at both Strathpeffer and Dingwall are at present equipped with two 50kw. three-phase transformers, having a voltage ratio of 3000 to 345, the pressure between either of the three principal conductors and the neutral on the low-tension side of the switchboard being 200 volts. The distribution from the

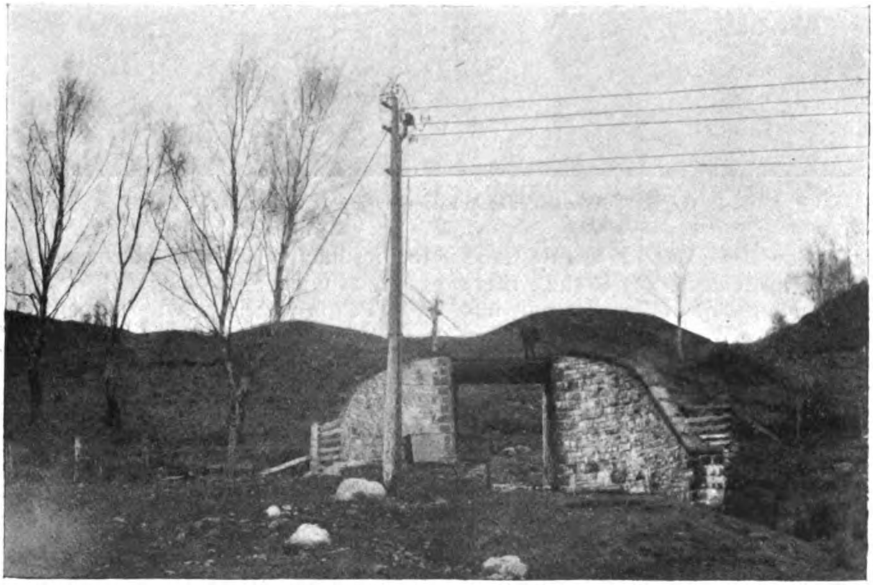


FIG. 8. TRANSMISSION LINE CROSSING THE RAILWAY.

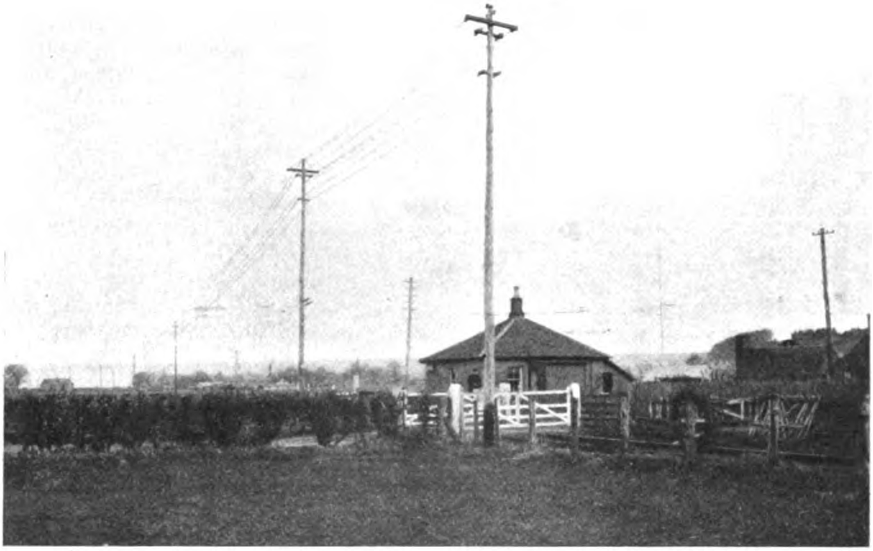


FIG. 9. TRANSMISSION LINE RAISED OVER A LEVEL CROSSING.

transformer-house is in both towns by three-phase cables, made according to the writer's patent, in which the neutral wire is split into three parts, each of which lies between adjacent principal conductors. House services for small installations are connected to one principal conductor, and the neutral, but large, installations are connected up to all three phases, the circuits in the buildings being approximately balanced. The streets in Strathpeffer are lighted by incandescent silvered lamps, two of 16c.p. being placed in each lantern. The charge for this public lighting is 4.8d. per unit, and while giving two or three times the light the cost comes to just the same as with the previous oil lamps. The charge for private lighting is 6d. per unit both in Strathpeffer and Dingwall, gas in the latter town costing 6s. 8d. per 1000 cubic feet.

Mr. G. J. Hunt, who erected the plant for the contractors, and was responsible for the supply until the works were taken over by the purchaser, has kindly given me figures showing the overall efficiency of this undertaking, as tested on completion. The water used at the power-house was measured, and when the consumption corresponded to 190 hydraulic h.p. the return obtained at the low-tension bus-bars at Strathpeffer, three miles away, was 120 e.h.p. This shows an overall efficiency of 63 per cent., and it would be the resultant of individual efficiencies, probably as under:—

Pelton wheels ...	76 per cent.
Generators	90 ,,
Transmission line	94 ,,
Transformers ...	98 ,,

When transmitting all the energy to Dingwall, six and a quarter miles from the power-house, the return for the same water consumption was 118 e.h.p., the lower efficiency being due to the greater length of transmission line. In conclusion, it may be mentioned that this interesting installation has been working with the greatest success since the middle of 1903, though the description of it is published now for the first time.

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The Field of the Portable Tool.

It is always urged as an argument favouring the use of electric power that its extreme flexibility prompts its application to portable tools. For many years portable electric tools have been exploited, but only since their design was carefully studied and data collected of their performances have they come to be regarded as serviceable acquisitions to the long list of industrial power tools.

Mr. Andrew Stewart recently dealt with the subject in a paper before the Glasgow Technical College Scientific Society, tracing the history of such tools and giving practical details of their modern design and behaviour under working conditions. The paper as a whole makes instructive reading, and we extract a few of the chief points touched upon, as well as two useful illustrations. Ventilation is a vital factor with the small motors employed, and the author says: "The most important limiting factor with these motors is heating; sparking at the commutator, while a factor, does not impose any limit before the heating becomes excessive; indeed, by careful design the influence of sparking may be eliminated, and that due to heating only remains. Here, due to the ingenuity of Mr. W. O. Duntley, Vice-President of the Chicago Pneumatic Tool Company, a novel method of getting over the difficulty was introduced into their portable electric tools, and one which has proved remarkably satisfactory. By the use of a small four-blade fan on the armature spindle sufficient air is blown through the armature, where quite 80 per cent. of all the internal losses take place, to keep it cool. The result of such an arrangement is that whereas, under normal working conditions, an unventilated motor had to be stopped after ninety minutes' run on varying load, owing to the fear of burning out the insulation, the same machine with the fan had a rise of temperature of only 110 degrees Fahr. at the hottest part, after four hours' run on a varying load such as drilling holes. These fans consume very little power. Careful tests show a consumption of 1/60th to 1/70th of a horse power, but notwithstanding this small power the fan is effective enough in keeping the machine cool."

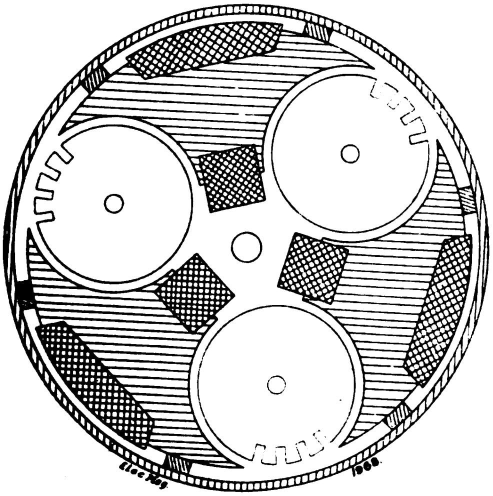


FIG. 1.—SECTION THROUGH THREE-ARMATURE DRILL.

On the subject of three armature drills, Mr. Stewart gives some useful data, comparing them with the single armature type. A diagrammatic illustration of such a machine is shown in Fig. 1.

"This type presents the outstanding advantage of utilising every available bit of space in the machine; even the small space at the centre can be used to take the feed screw. This remarkable design has been criticised by many, but the chief feature of the criticism is the inability of the critics to demonstrate that any alternative they propose is superior to the three armature machine; and as most of you know, and those who don't will soon learn, a negative policy is no use either in engineering or anything else. With such a design an important reduction in the weight is obtained over that of a single armature machine, while the linear dimensions can also be reduced because of the more efficient utilisation of the space. These advantages are clear from the table below, which shows the relative weights of the essential parts of a three armature and a single armature drill.

1.75 *B.H.P. Motors for Electric Drills.*

	Single Armature.	Three Armature.
Armature	7lb.	10.85lb.
Field (including winding)..	30lb.	19.5
Total	37lb.	30.35lb.
Weight of machine	60lb.	58lb.
Ratio of active material to total weight	.62	.525

"In each case the non-magnetic parts were of aluminium as far as possible. The slight disadvantage under which the three armature drill labours by having three sets of brush gear and additional leads reduces the ratio of the active material to total weight.

"The pinions of the three armatures gear into a spur wheel, which has a pinion on the same shaft, the subsequent reduction being by suitable gearing.

"Drilling pillars are usually fixed by bolts and nuts in the desired position, but the use of a magnet in the base of the pillar as a substitute for the bolts and nuts possesses so many obvious advantages that its use is inevitable. To fix a pillar by merely turning a switch is practically an instantaneous operation, while the fixing of the same drill post by means of bolts and nuts presents so many opportunities to the workman to carry out his great plan of so little work for so much money that its practical extinction would not be regretted except by the workman, who in a given time would drill at least twice as many holes as formerly. The design of such posts and the considerations involved in the production of a cheap and efficient type of magnet, led the author years ago to adopt the concentric type of magnet for somewhat similar purposes, and when it became necessary to design magnets for holding down these drill pillars this type suggested itself, not only on account of economy, but because it was the only type which gave good mechanical protection to the windings.

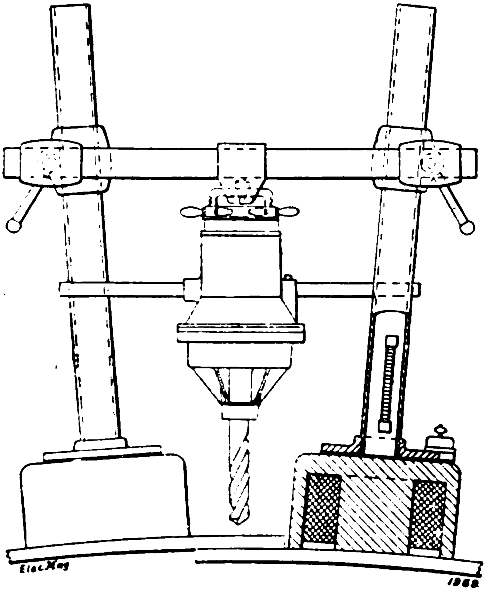


FIG. 2. DOUBLE MAGNETIC DRILL PILLAR, WITH ELECTRIC DRILLS.

"The tenacity with which a magnet sticks to anything is roughly proportional to the square of the density of the magnetic induction; hence exciting power is of more importance than mere area of iron, and those magnets where the contact area is increased by the addition of a pole shoe to increase the area at the point of contact, show that the designers forget that the principles which apply to the design of dynamo magnets must be reversed, so far as the air gap is concerned, when applied to magnets for lifting or pulling purposes.

"For large holes a double post is employed. These can be designed to give pulls of the order of four tons or thereby, and will hold down against drills cutting 2½ or 3-inch holes. A form of double-post is shown in Fig. 2, which will give a good idea of the general arrangement of such posts, and the section shows how the outer pole protects the windings from mechanical injury. In order to make these holding-down magnets more suitable for use on irregular surfaces, the writer some time ago designed magnets with movable cores which would adjust themselves to variations of the surfaces to which they were attached, and so avoid the diminution of pulling power which takes place when the magnet face does not make proper contact with the surface to which it is to be attached.

"Tables I. and II. given herewith are compiled from data of the performance of electric drills. Table II. deals with the three armature drills.

TABLE I.

Speed of Drill Spindle.	Weight of Tool.	Size of Hole.	Depth.	Time to Drill Hole.	Metal.	Volts. × Amps.	Watts per lb. of metal per min.
Revs.	Lbs.						
800	13	⅜"	1½"	65 sec.	Cast-iron	305	7200
450	17	½"	1½"	2 min.	,,	330	4230
250	30	⅝"	½"	40 sec.	Steel	495	8448
250	30	⅞"	1½"	70 ,,	Cast-iron	660	3300
150	32	1"	1½"	2 min.	,,	550	3666
150	32	1"	½"	80 sec.	Steel	495	6447
150	32	1¼"	1½"	3 min.	Cast-iron	440	4125
100	52	2"	1½"	3 ,,	,,	990	2564

TABLE II.

Speed of Drill Spindle.	Weight of Tool.	Size of Hole.	Depth.	Time to Drill Hole.	Metal.	Volts. × Amps.	Watts per lb. of metal per min.
Revs.	Lbs.						
150	48	1¼"	1½"	2 min.	Cast-iron	770	3200
100	58	1¼"	2¼"	1¾ ,,	,,	1320	2620
100	58	1¾"	3"	4 ,,	,,	1540	3286
100	58	2"	2"	2½ ,,	,,	1880	2940
100	58	2¼"	2¼"	4 ,,	,,	2200	3040
100	58	2"	1¾"	2½ ,,	Mild steel	1860	4650

Individual Tool Drive.

In the field of power application, experiments are constantly being made and data collected from the use of individual motors for the operation of tools. The subject is one of extreme interest, while its important bearing on electric-power development demands that it should receive close attention at the hands of experts. Mr. G. M. Campbell recently presented some valuable results of tests conducted by him on motors driving various heavy tools before the Engineers' Society of Western Pennsylvania, and we extract several sections which will be found useful for reference.

The author states that "the power taken by a machine, after allowance was made for friction losses, will vary approximately as the speed and cut and therefore as the weight of metal removed, consequently in fitting motors to tools due allowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high-speed tool steels and the increase in rigidity of machines. A formula for the amount of power absorbed in cutting may be stated thus:

$$H\,P = K\,W$$

"Where H P = horse-power, K = a constant depending on the kind and grade of material, W = weight of metal, pounds removed per minute. Values of K may be taken as follows:

K = 2.5 for hard steel
= 2.0 for wrought-iron
= 1.8 for soft steel
= 1.4 for cast-iron.

"This formula is simply a general one; the power required in any particular case will vary perhaps 100 per cent. according to the condition of the cutting tool.

"There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take; this is the reciprocating tool as the shaper and planer and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives where motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it are of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a fly-wheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

"In the shops of the Pittsburg and Lake Erie Railroad Company, at McKees Rocks, there are about eighty machines driven by individual motors. For variable speed work the speed variation required in the motor was, in general, about 2.8 to one for full power, but up to from six and seven and one-half to one for diminished power at low speeds, and the size of motor was approximately double the horse-power required by the machine throughout this full-power range —*i.e.*, if the motor was rated as a variable-speed motor, it would have a rating approximately one-half that of the constant-speed rating. The speed variation in many instances differed considerably from the above. In many of the drills, the speed variation was higher, and in planers, shapers, &c., lower. The speed control in these shops is obtained by means of the multi-voltage system. The horse-power required by the machine was determined partly by general considerations and partly by the formula stated above, HP = KW, where K had a value of 3.6 for hard steels and 2.5 for soft steels. From data given on previous pages, it may be seen that the size of this constant was on the safe side. All machines are protected by both circuit-breaker and fuses; the size of the breaker was, in general, four amperes per rated horse-power of the motor and it was set at the limit of fifty per cent. above this rating; the breaker would therefore fly out when the power consumption was approximately 100 per cent. overload. On reciprocating tools, the circuit-breaker was set forty to fifty per cent. higher. The enclosed fuses used had a rating the same as that at which the circuit-breakers were set. After the plant was in operation a large number of tests was made, every machine listed being tested to see whether or not the motor capacity was sufficient. In no case is the motor too small. In a few cases the motor could easily be reduced. Table I. is a sample of the tests taken, and serves to illustrate the results obtained from the individual operation of a boring mill.

Table I.—72-inch Boring Mill.

Motor—25 h.p. at 750 r.p.m., 230 v. 90.5 amp.
R.p.m. of Table = 2.35, 0.97 or 0.34 per cent of motor.

Motor.					Cut.			Material.			
Controller Point.	Voltage.	Current.	R.P.M.	H. P. Input.	Feed. Inches.	Depth. Inches.	Speed. Ft. per Min.	Diam. Inches.	Weight. Pounds Min.	Kind.	Remarks.
18	240	4	...	...	...	... ...	...	...	...	... ...	Running light, table not turning
18	240	6	...	...		...	...		...	...	Running light, table turning.
18	...	20	785	...	.125	.125 & .125	...	19.5	...	Cast-iron	Two heads.
21	233	28	970	8.76	...	... ...	...	...	...	... ...	Running light.
21	233	38	978	11.88	.0625	.094	47	7.5	0.09	Brass	
21	232	37	988	11.51	.0625	.0625	47	7.5	0.66	,,	
4	76	38	243	3.77	.0625	.375	28	58	2.05	Cast-iron	
9	116	16	361	2.49	...	... ...	...	...	...	... ...	Running light.
8	76	49	340	4.98	.0625	.25	39	58	1.90	Cast-iron	
12	115	33	480	5.08	.125	.062 & .031	44	44	1.24	Steel	
10	114	28	473	4.27	.125	.0625	42	44	1.11	,,	
13	160	19	519	4.07	...	... ...	...	...	...	...	Running light.
9	113	75	354	11.36	.125	.125 & .125	51	52	5.41	Steel	
9	112	95	349	14.26	.125	.187 & .187	48	52	7.65	,,	
9	115	58	360	8.93	.125	.125 & .187	47	52	3.75	,,	
17	195	25	684	6.54	.125	.125	80	19	4.50	Brass	
21	234	35	964	11.00	.125	.094 & .031	123	20	6.91	,,	
20	235	30	915	9.47	.187	.031 & .016	115	20	3.64	,,	
20	236	20	930	6.33	...	... ...	...	...	...	... ...	Running light.
20	244	13	940	4.25	.083	.125	33	18	1.07	Cast-iron	
6	78	26	294	2.72	.083	.125	33	18	1.07	,,	
15	161	15	612	3.24	.062	.062	24	20	1.29	,,	

Electric Power in Coke Manufacture.

At the present rate of the application of electric power to industrial purposes it will shortly be difficult to name any single process in which motors do not figure. An instance of the revolution effected by electric power in a special line of manufacture is that of coke-making, and here, as in other cases, the capacity of the plant has been notably increased, with a corresponding reduction in operating costs. Mr. H. S. Knowlton, writing on the subject in the *Electrical Review*, New York, clearly indicates the advantages of the motor drive, and points out the wasteful nature of steam plant :—

"Non-condensing steam engines are usually employed to drive the various crushing, rolling, screening, washing and pumping machines which prepare the coal for the coke ovens, and it is a question if it would not in many cases pay to substitute electric motors in this work. With electric larries power must be either purchased or generated by the coke manufacturer, and there is no question of the inefficiency of the ordinary single cylinder hoisting engine in comparison with the electric motor. Of course, coal is generally extremely cheap at a coke oven plant, and the total cost of crushing per ton of 2000lb. frequently falls below one and one-half cents, while the cost of putting a ton through jigs and washers does not, as a rule, in good practice exceed ten cents. But the engine plant requires nine skilled operators; the steam consumption per horse-power-hour is liable to exceed 250 or even 300 pounds, against, say, forty pounds per motor horse-power-hour in a generating plant which operates water-driven larries, electric lights, crushers and jigs upon a small well-designed wiring system. The saving of even one-quarter of a cent per ton in crushing and washing would, in a coke plant turning out 3000 tons per day, amount to 2250 dollars per year, so that it is plainly evident that small economies are not to be despised even in plants where fuel is exceedingly cheap. An outfit of enclosed motors for coke-manufacturing service does not require anything like the attention in the way of oiling and maintenance which a large outfit of donkey engines demands, and as coke manufacturers realize the advantages of electricity for the severe service which their plants require, the present increasing use of electric power is sure to bear good influence in the productive economy of the coke business."

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Large One-phase Locomotive Construction.

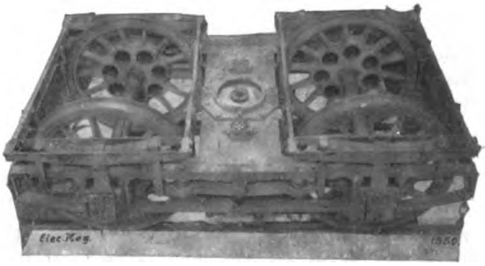
We have frequently referred in this section to the New York—New Haven one-phase development and the controversy which arose out of the decision of the company to abandon direct-current working over its longer stretches of track. We are now able to present our readers with some details of the locomotives to be used, and as these are of decidedly novel construction the particulars will be followed with some interest. The matter was recently made public by Mr. B. G. Lamme in a lecture before the New York Railroad Club, and the paper presented is useful for reference in that it covers the rise and development of one-phase railway systems :—

The mechanical construction of the locomotive presents many novel and interesting features which deserve special consideration. The running gear consists of two trucks, each mounted on four 62-in. driving wheels. The length of wheelbase is 8ft. The side frames are of forged steel and to them are bolted and riveted the pressed steel bolster carrying the centre plate. The weight on the journal boxes is carried by semi-elliptic springs with auxiliary coiled springs under the ends of the equalizer bars, to assist in restoring equilibrium. The bolsters are 30in. wide at the centre plate, and are widened, where bolted to the side frames, to nearly double this amount, thus giving a very strong construction without excessive weight. The centre plate which transmits the tractive effort to the frame is 18in. in diameter, and will be lubricated to permit a perfectly free motion in curving. The truck centres are 14ft. 6in. apart.

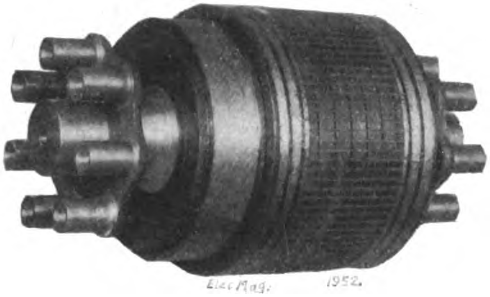
Owing to the fact that the entire space between the wheels is occupied by the motors, it was impossible to transmit the drawbar pull through the centre line of the locomotive in the usual way. Instead of this strong plate girders heavily cross braced are carried outside of the wheels and the entire strain of the drawbar is carried to these through strong box girders having top and bottom plates 42in. wide.

The motors are four in number, each of 250h.p. nominal capacity, but with a continuous capacity of over 200h.p. each, or over 800h.p. total. The motors are of the gearless type, and are wound for a normal full-load speed of about 225 r.p.m. They are connected permanently in pairs, and require about 450 volts at the terminals on alternating current, and 550 to 600 volts on direct current.

The frame and field of each motor are split horizontally, and can be removed in halves in order to give access to the inside of the field or to the armature. The armature



Truck of One-phase Locomotive.



Armature and Driving Pins of One-phase Locomotive Motor.

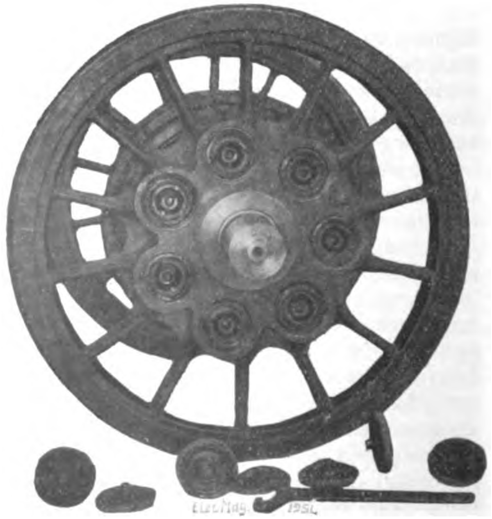
is not placed directly on a shaft, but is built up on a quill through which the car axle passes with about ⅝in. clearance all around. On this quill, at each end, are placed bearings which carry the field frame.

At each end of the quill is a flange from which projects seven round pins, parallel to the shaft, into corresponding pockets in the hub of the wheel. Around each pin is placed a coiled spring wound with the turns progressively eccentric. These springs are contained between two steel bushings, the smaller of which slips over the pin, and the larger fits in the pocket in the wheel. These springs are amply strong to carry the entire weight of the motor, but are normally required to transmit only the torque of the motor and to keep the motor axis parallel to the axle. They allow a total vertical movement of about ¾in. The end play of the motor, instead of coming directly on the wheels, is taken by strong coiled springs inside of the driving pins which press against covers in the outer ends of the spring pockets in the wheels. The torque on the motor frame is taken by heavy parallel rods which anchor the frame to the truck above and below the axle. These rods permit vertical or side motion of the motor, but prevent excessive bumping strains from coming on the motor-driving spring. The entire weight of the motor is normally carried on springs supported from a steel frame surrounding the motor and resting on the journal boxes.

The motors are internally of the same general type which the Westinghouse company has been building for some time for interurban service. However, due to the relatively low speed of the motors, the maximum commutator speed is very low, being less than 3000ft. per minute when the locomotive is making sixty miles per hour. This may be compared with 5000ft. to 7000ft. commutator speeds which are frequently attained in both d.c. and a.c. high-speed service with fairly large motors.

One interesting feature in these motors is the method of cooling. As a blower is used in the locomotive for cooling the lower transformers, it was decided to extend this method of cooling to the motors also. In the floor of the cab is an air conduit of considerable size from which air is piped to each motor. A further very great advantage in this method of cooling lies in the fact that the motors can be kept very clean in this manner, as the inside of the motor is kept under partial pressure at all times, tending to keep out dust and dirt, as all air-flow is outward. The air furnished to the motor, being taken from the inside of the cab, can be kept relatively clean and dry.

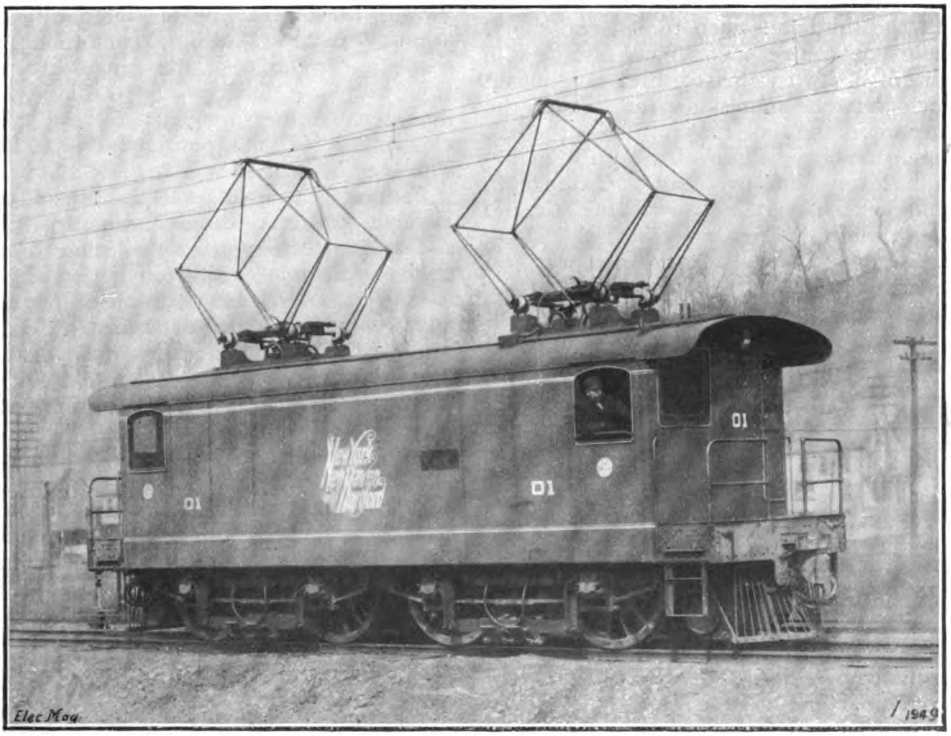
On a.c operation no resistance is used in regular running, but a slight amount is used in passing from one working step to the next, this being in the nature of a preventive device to diminish the short-circuiting effect when passing from one transformer tap to another. There are six operative voltages, or running points, on the a.c., corresponding to six taps on the lowering transformer, while there are a small number of intermediate steps which are used only in passing from one working point to another.



End View of Driving-wheel, showing Pockets for Driving Pins.

Experience has shown that the number of steps on a.c. required to give a smooth acceleration is considerably smaller than required on d.c. In consequence the controller is so arranged that on a.c. about half as many steps are used as on d.c. The tests have shown that the acceleration on both a.c. and d.c. is very smooth.

There is one feature in the d.c. control which is not generally found at the present time on direct-current equipments—namely, shunting the field for higher speeds. On the series position on d.c. the motors have an efficient running point. It is usual railway practice to pass from the series to multiple position by introduction of resistance, there being no intermediate efficient running speed. On the New Haven equipments, however, the type of motor used is one which permits an almost indefinite shunting of the field without affecting the commutation or operation otherwise, and advantage is taken of this to obtain several higher speeds by shunting the fields before passing into multiple. In this way several efficient running points are obtained between the series and multiple. The tests have shown that these motors will operate in a perfectly satisfactory manner on direct current with their fields shunted down to much less than half their normal strength.



View of Complete 1000h.p. One-phase Locomotive.

On alternating current step-down transformers are used, as the a.c. trolley voltage is 11,000. The step-down transformers are two in number, one on each side of the cab, in order to balance the weight in the cab. These transformers are the heaviest single pieces in the cab, and there would be considerable difficulty in placing a single transformer to advantage. A further reason for two transformers is that an injury to one would not entirely disable the locomotive. The transformers are connected in parallel across the high voltage, but on the low voltage side each transformer feeds one pair of motors, through a separate control unit. This means that the controller when operated on a.c. consists of two normally independent units.

The main controllers are operated from

master controllers at each end of the cab. The controller system is arranged for multiple unit operation so that two or more locomotives may be coupled to the same load.

The locomotive is equipped with devices for collecting both alternating and direct current. For the latter there are eight collecting shoes, four on each side of the locomotive, arranged in pairs of two each. There are, of course, two pairs on each side, one at each end, for the purpose of bridging such gaps as are necessary in the third-rail system. There must be shoes on each side, as the locomotive must be able to make contact with the third rail when turned end about. These d.c. contact shoes must also be able to work on two forms of third rail, one in which the shoe runs under the rail, and the other where the shoe runs on top of the rail. The locomotive is provided with a pantagraph low-tension overhead d.c. trolley to conform with certain New York Central requirements. For collecting alternating current the locomotive is provided with two pantagraph type high-tension bow trolleys, and each has a capacity to carry the total line current under average conditions, but two are provided to insure reserve capacity.

Each of these locomotives is to be able to handle a 200-ton train in local service on a schedule of twenty-six miles per hour, with stops averaging about two miles apart. In order to make this average speed the maximum speed will be about forty-five miles per hour. One locomotive will also be able to handle a 250-ton train on through service. For heavier trains than this it is intended to couple two locomotives together and operate them in multiple. This presents no difficulties, for, as stated before, the locomotives are fitted up for the multiple unit system of control.

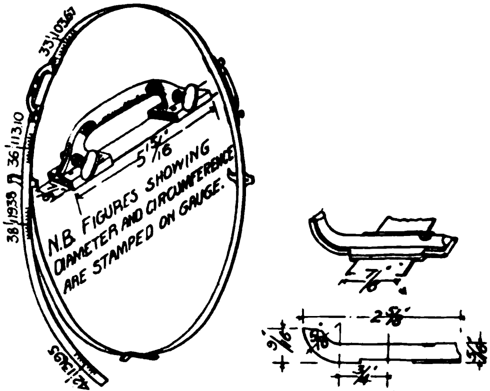
It is evident from the above description that the engineers of the New Haven Railway Company have had in view the adoption of an electric system which is particularly well adapted for future extensions. If the electrification were to stop at Stamford, then the full advantage of the alternating system would not be obtained. However, the section which will be electrified with alternating current is of sufficient length to enable the New Haven Railway engineers to determine the advantages and possibilities for future extension, and it is safe to predict that such extensions will be made in a comparatively short time.

Excessive Wheel Wear.

By F. M. NICHOLL

IN the mating of wheels, many electric railways do not recognise the importance of the use of the circumference measure, Fig. 1. The calipering of wheels, no matter how carefully done, does not serve the purpose. The distance to be spanned requires calipers of large dimensions, and if these are of serviceable weight, they must be of light material, and hence are too flexible for exactness. By the use of the circumference measure, as shown, wheels may be measured with the utmost exactness. Lugs, conforming in shape to the throat of the flange, are provided at frequent intervals on the tape, and these enable measurements to be taken closely and in like positions on the two wheels to be mated.

Frequent causes of excessive wheel wear are uneven wear or extreme hardness of brake-shoes; large variation in the gauge of the track in connection with worn or narrow rails; lack of and insufficient elevation of the track on curves; poor quality of the material in the wheel, and lack of uniformity of its texture. Sometimes the cause may be an unbalanced condition of the car body, which throws undue and constant pressure on all the wheels on one side of the car. This latter condition is a very serious and expensive one, and is especially the case with single-end cars. It can be best remedied by placing counteracting weights on one side of the car, thus righting the car body. Installing heavier springs in the trucks on one side of the truck,


33/103.67
36/113.10
38/119.38
42/131.95
5 15/16
N.B FIGURES SHOWING DIAMETER AND CIRCUMFERENCE ARE STAMPED ON GAUGE.
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2 5/8
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CIRCUMFERENCE MEASURE. DETAIL OF LUG.

FIG. 1.

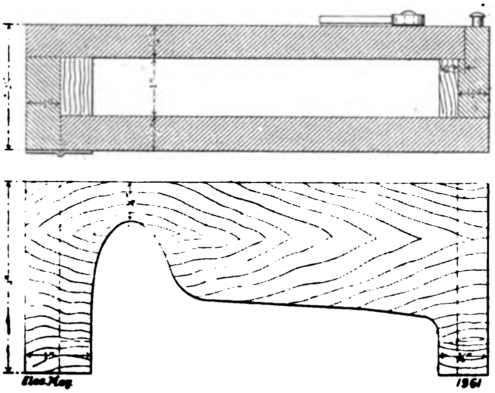


Fig. 2.

as is sometimes done, does not equalize the weight, and therefore does not remove the excessive wear.

The proper clearance between side bearings, permitting the free radiation of the truck and its adjustment to the inequalities of track, is also essential to good wheel wear, though of greater importance from a point of safety. Steam railroads usually allow 1-16in. on each side between the side bearings of passenger coaches, and $\frac{3}{8}$in. on freight cars. In each case due allowance is made for deflection of bolsters, and adjustment is provided for wear of centre plates. These centre plates are narrow under the bearing to aid the free radiation of the truck.

For the purpose of maintaining a more complete wheel record, and in order that the various causes of excessive wear, as above mentioned, may be determined and noted in the early life of a wheel, the following method will be found desirable.

Having adopted a certain standard of design or designs of tread and flange, a facsimile of the contour of the face of the wheel should accompany the record of each wheel. At regular intervals of not less than thirty days, impressions should be taken of the wearing surface of all wheels by means of plaster of Paris casts. The sharp outline of the cast may then be drawn by means of a hard pencil on the record within the original facsimile, and the most minute detail of wear may then be observed. Comparisons may then be made with mileages, as shown opposite each outline. The plaster impressions may be taken very easily, and without the removal of wheels from the truck, or the truck from the car. The entire operation does not require more than 15 minutes, and with a number of moulds one man should be able to complete one car an hour, or ten cars per day. The mould, Fig. 2, is constructed of pine or other white wood in the form of a box without a top. The bottom is cut away to allow placing on the wheel. The two sides and ends are hinged, and a hook is provided for opening and closing. The interior surface of the box is shellaced and rubbed down several times, and when taking an impression, the surface of the wheel is oiled to prevent the plaster from adhering and to obtain a well-defined outline. To prevent the fluid plaster from running through the openings at the corners of the form, caused by the wear of the wheel, oil-soaked waste is used to surround the mould, and after the removal of the mould from the cast, a sharp knife is used to trim the impression to obtain the true contour.

This method of taking casts may also be advantageously used during tests to determine the different effects on the wheels of various types of brake-shoes. In steam railway practice, the method is employed extensively to obtain impressions of defective wheels under foreign cars which have caused, or are thought to have caused, an accident. On interurban roads operating a small number of heavy "single-ended" cars with steel-tyred wheels, and where facilities for turning and truing are not at hand, the cost of maintenance of wheels, due to the excessive flange and tread wear, amounts to a large proportion of the cost of maintenance of entire rolling stock, and thus decreases to a large degree the net profits from operation. —*Street Railway Journal.*

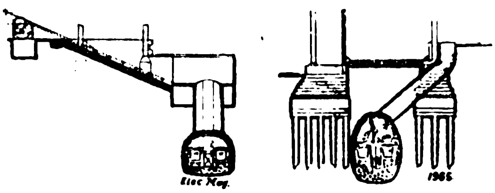
Underground Mail Transport.

While the London mails are being handled by such surface transport methods as motor vans, horse carts, bicycles and messengers, a comparatively slow process, experiments are afoot in Chicago for express mail service in the underground tunnels to which we have previously referred. According to the *Western Electrician*, these tests have proved highly satisfactory, and it is probable that the system will be followed in other large towns.

When it is inaugurated the mail between the post office and the railway and sub-stations will be handled much more rapidly than is now possible with eighty-five mail waggons. This is the first underground electrical arrangement for handling of mails in the United States, and the officials of the Post Office Department are watching the development with keen interest. Fig. 1 is an elevation through the centre of the tunnel, looking east, and shows also the location of the chutes for dropping the mail down to the tunnel cars, and the conveyor system for raising it from the cars into the building. The mail pouches are thrown down the chutes from the mailing platform in the post office and are delivered upon the mailing platform in the tunnel, where they are placed on the mail cars and sent to their destination. In-coming mail from the depots and sub-stations is unloaded from the tunnel cars on to the tunnel platform and from there placed on the conveyor and taken up and delivered on the mailing platform in the post office.

The conveyor is a large belt 30in. in width, motor driven. It travels horizontally in the tunnel for a distance of 90ft., then it ascends on an incline to a point just below the driveway under the building. At this point the pouches are deposited on a cross belt, which delivers them to the mailing platform. Fig. 2 is a section of the tunnel, showing the conveyors. Fig. 3 is a cross-section showing a mail chute which delivers the bags to the mailing platform in the tunnel. During the test a train of mail cars travelled from the post office to the La Salle Street station, deposited its burden, and was ready to leave on its return trip in three minutes. This distance is short, but for a team on the crowded streets above to make any such time would be out of the question.

It is impossible to see where the system can be outgrown by increasing business of the post office. The noiseless belts move continually and all that is needed to keep the system in proper operation is sufficient men to remove the bags from them as they arrive in the sorting and mailing rooms. The underground railroad will carry, it is said, more than forty times the present capacity of the post office and in about one-tenth the time consumed by the waggons now drawn by horses.



Figs. 2 and 3.
Sections through Tunnel at different Points.

Two-motor v. Four-motor Equipments.

Considerable interest attaches to the relative power consumption of cars fitted respectively with two and four driving motors, and a recent report on the subject, made public by a Baltimore electric railway company, will be found to contain valuable comparative data, taken from tests made by its officials. In each instance the tests extended over two days, and were made not so much to establish the theoretical relative economy under ideal conditions, but to determine the relative power consumption of the two types of equipment as operated regularly in Baltimore. Car No. 710 had a 31ft. body mounted on double trucks with 33in. wheels, and was equipped with four motors, giving a total of 160h.p. in motors to the car. This car complete weighed 45,000lb. light and had a seating capacity for forty-four passengers. Car No. 730 had the same length body on maximum-traction trucks with 33in. driving wheels, and was equipped with two motors, giving a total of 110h.p. This car weighed 31,700lb. light and had a seating capacity for forty-six passengers.

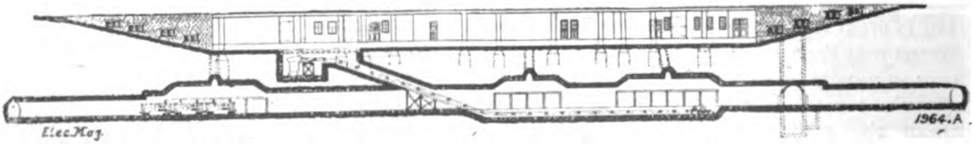
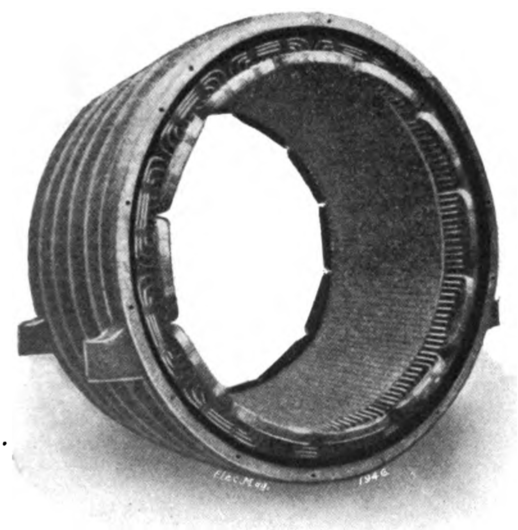


Fig. 1. View of Mailing Station in Tunnel.



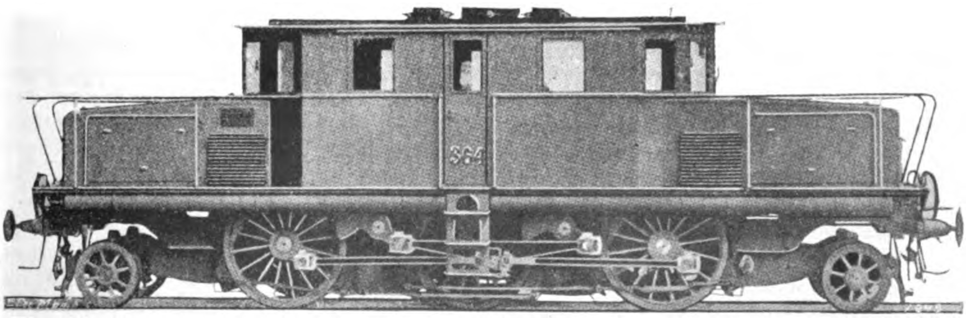
Stator of 500h.p. Three-phase Motor for Simplon Tunnel Locomotives.

From the summaries adjoining it will be noticed that under practically the same running conditions as regards line speed, gear ratio, seating capacity, number of stops and passengers carried, the four-motor equipment consumes but 10 per cent. more current per car mile than the two-motor equipment. The two-motor car was equipped with hand brakes only, while the four-motor was fitted with air brakes, and it is possible that the current consumed by the two-motor equipment was slightly increased by reason of the motorman running with the hand brakes partly set in order to enable him to make his stops quickly. It is also probable that the two motors on car 730 were working at a disadvantage in that they were not altogether heavy enough for the service. The same motormen were used upon corresponding trips in each test.

	Car No. 710	Relative percentage	Car No. 730	Relative percentage
Type of equipment	4 motors		2 motors	
Horse-power . .	160h.p. total	100%	110h.p. total	68.7%
Gear ratio . . .	18-66 or 1:3.66	100%	18-64 or 1:3.56	.97%
Weight	45,000lb.	100%	31,700lb.	70.5%
Average kw. . .	28.47	100%	25.65	90%
Average amperes (assuming voltage 500) . . .	56.95	100%	50.6	90%
Kw.-hour per car mile	3.525	100%	3.17	90%
Kw.-hour per ton mile	.1565	100%	.200	128%
Average passengers carried per round trip . .	145	100%	148	102%

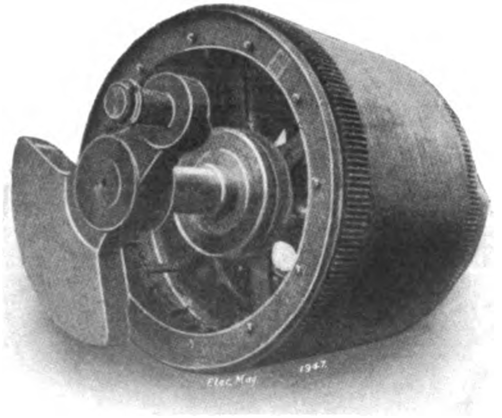
Simplon Tunnel Locomotives.

We have previously announced that polyphase locomotives are to haul the trains through the recently completed Simplon Tunnel, and we now give illustrations of the type of machine to be employed. They resemble the new class adopted for the Valtellina line, and from the adjoining general view it will be noticed that the method of drive is identical. The motors are placed high up on the frame and fitted with balanced cranks which are connected by a substantial coupling rod. The three driving wheels are also coupled together and the centre pair is connected to the motor coupling rod. The slip rings are not brought to the outside of the crank on the motor shaft, but are placed within the main carcase, as will be seen in the view we give of the motor with cranks complete. We understand that the polyphase system was chosen



View of 1000h.p. Three-phase Locomotive for the Simplon Tunnel.
The Bow Collectors are not in position.

mainly because a very brief time was available to complete the electrification and because Messrs. Brown Boveri, who contracted to complete the work in a short period, were building three-phase locomotives for the Valtellina railway in Italy. The hydro-electric stations used for the supply of power to the motors employed on the tunnel construction will serve the locomotives with current directly at 3,300 volts, 15 periods, and no transformers will be used while the electrification is confined to the tunnel proper, its length being 12 miles. The locomotives will develop between 900 and 1000 h.p. and have speeds of 20 and 40 miles per hour. At the former a draw-bar pull of 6 tons will be exerted and at the latter of 3½ tons. It is understood that the service of electric trains will commence running in the present summer.



ROTOR OF 500H.P. THREE-PHASE MOTOR FOR SIMPLON TUNNEL LOCOMOTIVES.

Trams v. Motor 'Buses.

Mr. E. Manville recently presented a paper to the Automobile Club on the subject of the field of the electric tramway and motor 'bus, and in it he gave two balance-sheets comparing the respective systems, taking for the former the second year's accounts of the Leicester Tramways, and for the latter a series of figures for a motor 'bus service in the same town.

We have abstracted the main items from these accounts, and, while admitting that the comparison is decidedly favourable to electricity, it presents the case for the motor 'bus in a light which is certainly instructive.

Leicester Corporation Tramways.

Capital Account—	£
Net purchase price of old undertaking ..	118,000
Inclusive cost of reconstruction, extensions, and electrification, including power-house	540,985
	£658,985

EXPENDITURE.	£	s.	d.
To traffic expenses	40,281	15	5
To general expenses	8,681	8	10
To repairs and maintenance	7.810	13	10
To power expenses	7,054	1	9
Total working expenses	63,827	19	10
Estimated future increase in permanent way repairs..	1,977	10	0
Interest on capital and contributions to sinking fund	32,490	11	11
	98,296	1	9
Renewals of permanent way and paving	8,858	0	0
	£107,154	1	9

INCOME.		£	s.	d.
By traffic—				
25,890,030 passengers carried ..		108,111	2	11
By sundry revenue—advertising on cars		1,100	0	0
Rents of shops and cottage property		329	12	6
Average per car-mile	7.866 ..	109,540	15	5
Expenditure	7.095 ..	107,154	1	9
Profit on one year's working	.171 ..	2,386	13	8

Balance-sheet for Motor Omnibuses.

Capital Account—	£
140 cars at £900 each	126,000
Car depot and offices	48,000
Equipment of workshops..	10,000
	£184.000

EXPENDITURE.	£	s.	d.
To traffic expenses	42,922	16	5
To general expenses	13.837	2	0
To repairs and maintenance	7,659	6	4
To power expenses—Petrol	13,926	0	7
Total amount of working expenses ..	78.345	5	4
Interest and sinking fund capital ..	9,191	3	7
	87,536	8	11
Renewals — Tyres, Vehicles, 20 per cent. per annum..	52,971	7	2
	140.507	16	1
Interest and sinking fund on purchase price of old undertaking, £118,000..	5,900	0	0
	146,407	16	1
Income	109,211	2	11
Loss on one year's working	37,196	13	2

INCOME.		£	s.	d.
By passenger traffic—				
25,890,030 passengers carried ..		108,111	2	11
By sundry revenue, advertistising on cars		1,100	0	0
Average per car-mile	7.842 ..	109.211	2	11

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

A Point in Boiler-house Construction.

By W. H. BOOTH.

I ONCE came across an instance of a man in charge of a blowing engine who, finding his engine room somewhat draughty, boarded up the air inlets and nearly shook the building in pieces before he was found out and put right.

How many poor draughts in steam plants may not be somewhat similarly caused? Stand at either end of a long boiler-house, with the doors open, and there will be a strong current of air flowing in at each end. If the boiler-house is one of the more modern abominations, this air-current becomes simply a winnowing force, carrying all the fine dust forward, so that, excepting at the end boilers of the row, there is all the time a dust-laden breeze travelling toward the middle boiler. In a house of twenty boilers a little calculation will show that there may easily be 3000 and 3600 cubic feet of air per second required to supply the fires. If all this must come in at one door, opened, say, 15ft. by 15ft., the velocity of the air will be 20ft. to 24ft. per second through the door. One never sees a boiler-house where there appears to have been any real attention paid by the designer to the problem of air entrance. There are often louvres in the so-called ventilator roof, and these louvres are primarily intended to increase comfort by allowing heated air to escape. It is doubtful if they do often act in this way, and it is far more likely that they serve the very necessary purpose of admitting air to the furnaces. One thing is certain, it is bad practice to admit air by the end doors, for this promotes dust, which is raised by the strong and rapid draught and cannot again settle down, but is carried forward to render the boiler-house dirty, and the duty therein disagreeable.

It would greatly reduce the velocity of air-currents at every section were provision made by small air-inlet openings to provide the necessary supply to each boiler through a grating from below. Ventilation is often advocated to be downward in direction and there appear good reasons to believe that an air supply should be admitted above the level of the boilers, and it is clear that if the grate surface of the boilers is, say, 10ft. per foot of boiler-house length, such a provision of clear opening would be ample, or more than ample, for such a grate area, seeing that of any grate area never less than half is occupied by bar surface, and of the remainder the passage is more or less barred by fuel. Or we may calculate the actual air velocity through a given opening on the assumption of two tons of coal per hour in a double-banked house per 15ft. of length, or, say, 5lb. per foot of length per minute, which may represent approximately 20 cubic feet of air per second per foot-run of boiler-room. If an entrance velocity of 10ft. per second be permitted, it would be necessary to provide on each side of the boiler-house a series of slots 2ft. high and 6in. wide divided by 6in. pieces; that is to say, half the wall space along a strip of wall 2ft. wide. Whatever may be done, intentional provision for air should be made, and its entrance should not be left to fortuitous openings. —*Power*.

Reciprocating Engine Tests.

IN our last issue we published in this section a view of the large reciprocating engines used in the New York subway power-house. We have recently received from the Allis-Chalmers Company an account of the official tests, an abstract of which will be found to make instructive reading.

In accordance with the terms contained in the contract between the Allis-Chalmers Company and the Interborough Rapid Transit Company, the former guaranteed certain operative results under specified conditions, in effect as follows:

Each engine was not to require more than 12.25lb. of dry steam per indicated horse-power per hour, when indicating 7500h.p. at 75 r.p.m., with a vacuum of 26in. at the low-pressure cylinders, and with a steam pressure at the throttle of 175lb., said rating to include all steam used by the engine exclusive of auxiliaries. A further memorandum agreement formulated by the representative engineers of each company governed in detail the conduct of the test; this secondary agreement being necessitated by certain features peculiar to the case involving the very essential point of the original contract.

The swing of the generator load, which averaged approximately 12 per cent. plus or minus in three seconds, presented a prohibitive impediment to the use of the ordinary engine indicator as a standard for results. Thus the only method practicable was to obtain the developed electrical horse-power of the unit and correct this by the amount of the engine friction and generator losses as determined by subsidiary tests.

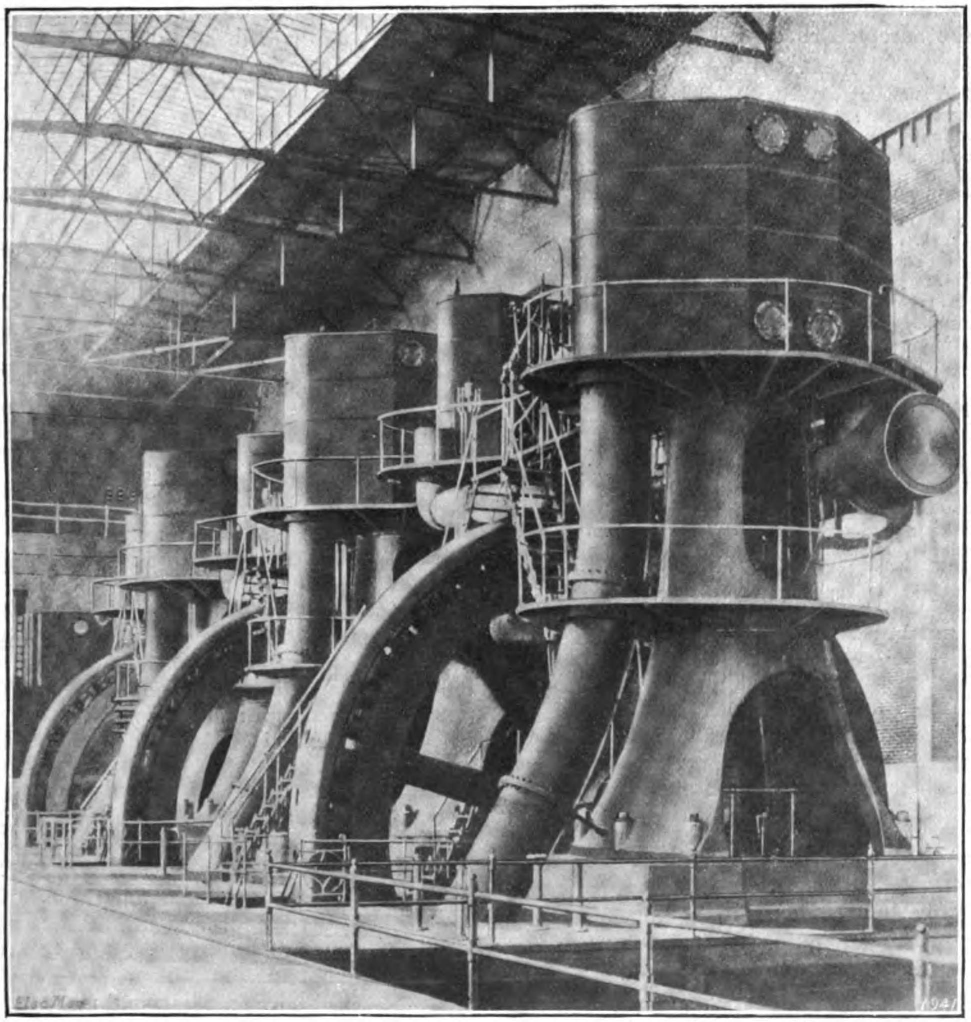
All steam and water mains and auxiliary lines in the unit were either entirely cut off from the rest of the house or separated by two valves and a drip valve between. The unit as thus isolated consisted of seven boilers, the water ends of a boiler feed-pump and a circulating pump, respectively, and the main engine.

Apparatus as required for the test was installed as follows: For weighing the total feed water as delivered by the supply line, four tanks, mounted in pairs upon two 24-ton scales, with a capacity per pair of 28,000lb. of water, were used. The water from the weighing tanks was delivered to two reservoir tanks connected by equalizers, and then in turn to the boiler feed pump. For weighing of drips, leakage, etc., small scales and tanks were erected as necessary. Due allowance was made for all known leakage and drips. Readings were taken at fifteen-minute intervals, an hourly graphical log being maintained.

The load on the engine was measured electrically, by means of four balanced three-phase watt-hour meters of the induction type, connected to current and potential transformers, located at the terminals of the alternator.

The combined losses in the unit were ascertained by driving the generator as a synchronous motor with the engine trailing, and measuring the watts input, which, it can be seen, would consist of combined friction and windage, I^2R losses and iron losses. As this input was too small to be measured accurately by means of the four load meters, a special meter with its standardized current transformer was used.

The unit could not be motored for periods longer than five minutes because of the difficulty in lubricating the cylinders, when not using steam, which time was not long enough to allow of obtaining a dial reading on the meter; so the meter during the short run was read by counting the revolutions of the disc, timing same with two chronograph watches reading to tenths of a second, the mean power being figured by the usual calibrating formula. During this period the field current was held at that value corresponding to full-load excitation in order to make the iron losses the same as at full load. The armature volts and amperes were also read at 10-second intervals in order to obtain the power factor, which, due to the over-excitation of the field at such small load, was low, averaging for the several trials 0.185, with a leading current. As the meter used for this test was calibrated at a power factor of 1.0, it was necessary to check it on low values, and readings were, therefore, taken with a leading current at 10 points from 0.1 to 1.0, and a curve plotted, showing the error, which curve was used to correct all readings taken on the friction trials. To this corrected input, as the armature current was below full-load value, was added the difference between the I^2R losses at the observed value and that corresponding to full-load current. From the above the output of the generator plus the input to the generator when run as a motor, plus the



Allis Vertical Engines and Fly-wheel Generators—a type of unit common to American Central Station Practice.

difference between the I^2R loss at motor current and the same at full-load current, equals the total load on the engine in kilowatts.

It was found difficult to obtain the exact friction load of the engine by means of separate indicator cards for the reason that the very small changes in cut-off, due to the governor, caused considerable variations in mean effective pressure.

Therefore, for the purpose of more accurately determining the friction a continuous indicator was designed, which instrument solved the problem of indicator application to the engine. This very ingenious instrument was so arranged that at about the middle of the exhaust stroke the indicator paper was moved forward a short distance, thereby separating the successive indicator diagrams. As the back pressure line was practically straight, no error was introduced and the cards presented the same appearance as if taken singly. The operation was automatic, and cards were recorded for each revolution. Using this device, two sets of indicator cards were taken on the engine running empty; one with the normal exciter current, and the other without the exciter. The results of these tests agreed so closely with those of the synchronous motor method that the latter were accepted as correct.

Results of Engine Test.

A summary of the test results is as follows:—

Duration..	15 hours.
Preliminary operations on load ..	2 hours.
Load (switchboard reading) ..	5079.2kw.
Friction and electrical losses ..	417.3kw.
Total load	5496.5kw.
I.H.P.	7365.3.
R.P.M.	75.02.
Steam pressure	175.18lb. (gauge).
R.H. receiver pressure..	19.1lb. (gauge).
L.H. receiver pressure	19.27lb. (gauge).
Barometer	30.5in.
Vacuum (actual)	26.02in.
Vacuum, referred to 30in. barometer	25.52in.
Temp. injection water	42.36° F.
Temp. R.H. discharge..	74.05° F.
Temp. L.H. discharge	77.38° F.
Water per hour	89,906lb.
Weighed drips from separator, &c., per hour	512lb.
Leakage per hour (leakage test)..	1470lb.
Boiler level correction per hour ..	60lb. (high).
Net water per hour	87,864lb.
Correction for superheat	0.28 per cent.
Equivalent dry steam per hour ..	88,110lb.
Dry steam per kw.-hour (switchboard)	17.34lb.
Dry steam per i.h.p.-hour engine	11.96lb.

It is probable that the result of 17.34lb. of dry saturated steam per kilowatt-hour with only 25.52in. of vacuum is the best ever obtained under similar circumstances.

The Generation of Steam.

THE first consideration in connection with the generation of steam is to ensure that the combustion of the fuel is carried out to the best advantage. Although combustion refers to all forms of chemical union, in our case it only refers to the burning or oxidisation of the fuel, and complete combustion is said to have taken place when all the combustible has been oxidised to its highest state of oxidisation. The elements of coal which contribute most largely to its heating power are carbon and hydrogen. There are besides several other constituents, which are, however, of little value, such as sulphur, etc. Each lb. of carbon during complete combustion develops 14,650 B.T.U.; each lb. of hydrogen 62,000 B.T.U., but a small portion of the hydrogen combines with the fixed oxygen in the coal to form water, and therefore it is usual in determining the calorific value of the coal to take this into consideration.

From the above we get the approximate calorific value per lb. of the coal to be $14,650\ C. + 62,000\ (H.\frac{O}{8})$ B.T.U. This averages about 14,000 B.T.U. Each lb. of carbon requires 2.66lb. of oxygen, or 11.3lb. of air, and each lb. of hydrogen requires 8lb. of oxygen, or 34lb. of air for complete combustion; or, approximately, the quantity of air required per lb. of combustible $= 12\ C. + 36\ (H.\frac{O}{8})$ = about 12lb. or 150 cubic ft. The amount of air usually required, however, is about double this, or 24lb. for natural draught, and about 50 per cent. extra, or 18lb., for mechanical draught.

The amount of heat generated per lb. of combustible is the same whatever the rate of combustion may be. It follows therefore that great latitude may be taken in this respect without affecting the total heat developed; but in practice it is found that other considerations limit this latitude, and that there are certain conditions necessary in order to get the most available heat from a lb. of coal. As the rate of transmission of heat between two bodies varies as the difference of temperature of the bodies, it follows that a high temperature of combustion is more efficient than a low one. This is easiest obtained with a thick fire and intense draught. A thick fire requires less excess of air, as the air has further to pass through the incandescent fuel, becomes more closely intermingled with it, and combines better with the carbon, &c.

The final result of combustion should be carbon dioxide, steam and nitrogen, with small quantities of other gases. Any trace of carbon monoxide shows incomplete combustion. Carbon readily combines with oxygen to form carbon dioxide at moderate temperatures, but at high temperatures it forms carbon monoxide, even with an excess of air. As 1lb. of carbon when burned to carbon monoxide only develops 4400 B.T.U., the loss is easily seen when compared with the B.T.U. developed when carbon dioxide is produced. Of course the heat generated by combustion should be expended in converting the water inside the boiler into steam, but it is also expended in other directions, which are direct losses. Some of these losses are heat used converting water in coal into steam, and heat required to raise all the products of combustion, the nitrogen in the air, and excess of air used for combustion, to the temperature of the gases leaving the boilers. These are unavoidable. There is also the loss due to radiation from the boiler walls, &c. This loss can be kept to a minimum if the walls are well built and thick, and provided with a smooth white and polished surface, which can be obtained by using glazed bricks, but is rather expensive. In some cases there is a large air leakage through the walls, which reduces the temperature of the escaping gases, and, although the heat lost is the same, it is apt to mislead one as to results unless carefully enquired into.

The arrangement of piping to carry the steam from the boilers to the various engines which they supply is often considered a matter requiring little thought, as it is supposed that if the pipes and valves are of the required strength, and reasonably well-made, no trouble or anxiety will be caused if they are carefully erected, whereas events have proved that many disasters have taken place from other causes, such as water-hammer, expansion or distortion due to variations in temperature, excessive vibration, and internal and external corrosion. Water-hammer is perhaps the easiest to guard against, but is undoubtedly to blame for the majority of the serious accidents, and is in most cases caused by faulty design, supplemented by want of care on the part of those working the plant. Many instances could be shown where pipes have been designed to withstand pressures greatly in excess of what was required, but still unsuccessfully resisted the stresses set up by steam-hammer; the pipe system should therefore be designed in such a way that an accumulation of water is impossible.

The feed piping is almost of as much importance as the steam main, and it is desirable to make this in the form of a ring, with branches from the top and bottom of the ring to each boiler. It is well known that greasy water hinders evaporation, and is a source of danger when deposited on the heating surfaces; therefore, to overcome this danger, some arrangement must be installed to filter the feed water before returning to the boilers. Many forms of filters have been designed, but the method of removing the emulsified oil by mixing the feed water with minute quantities of sulphate of alumina and carbonate of soda is considered one of the best at the present time. By the mutual interaction of these reagents, a precipitate is formed which envelops the oil particles; this precipitate separates into definite filterable masses, and is then removed by filtration, the clear filtered water being freed from every trace of oil.

Another system is that in which the air pump discharge is subjected to electrolytic action. The difficulty in passing electricity through a mixture of condensed water and oil is its high resistance, the mixture being almost an insulator, but by adding a small quantity of tap water to the water to be treated its conductivity can be made sufficient to enable the current to pass through at voltages commonly in use. The cost of working this system may be put down at one unit of electricity per 1000 gallons of water treated per hour, and in estimating this the extra cost of coal required should only be taken into account, and we may safely put this at ½d. per 1000 gallons. The current through the electrolytic cell is varied by the amount of make-up water introduced, but when this has been correctly adjusted there is no alteration in the current which passes through the cell, even if the supply of condensed water is varied.

It is advisable that every station should be supplied with a CO_2 recorder, as it enables an intelligent stoker to secure the best results from the boiler.—Abstract of paper by Messrs. Brierley and Robertshaw before Rugby Engineering Society.

Measuring Three-phase Energy.

THE ordinary method of measuring the energy transmitted through three-phase mains consists, as is well known, in connecting two energy meters with their series coils in two of the mains, and their shunt coils between these mains and the third mains, as shown in Fig. 1. Dr. Niethammer points out in an article in *Elektrotechnik und Maschinenbau* that errors are easily made in this connection, and also shows how the error may be readily discovered. Figs. 2 and 3 show two of these incorrect arrangements.

When the connections are correct (Fig. 1), the sum of the readings of the two meters can be shown to be equal to the total true energy—*i.e.*, to $3 \times E \times J \times \cos\phi$, where E is the $\sqrt{MS}$ value of the voltage per phase, J is the $\sqrt{MS}$ value of the current per phase, and ϕ is the angle of phase difference between E and J—the circuit being supposed to be balanced so that $e_1 = e_2 = e_3$ and $i_1 = i_2 = i_3$. If the phase angle ϕ is 0 (power factor unity), both meters read alike, but for all other power factors the readings are different—*e.g.*, when $\cos \phi = .87$ the right-hand meter reads only half as much as the left-hand one, at $\cos \phi = .5$ the right-hand meter stops altogether, and for $\cos \phi < .5$ it runs backwards.

Further, the difference of the two meter readings can be shown to be

$$A_1 = \sqrt{3}\ E \times J \times \sin \phi$$

when the load is balanced, so that

$$\tan \phi = \sqrt{3}\frac{\text{difference of readings}}{\text{sum of readings}},$$

from which ϕ may be obtained. When the coupling shown in Fig. 2 is used the conditions are quite changed. The sum of the two readings is now

$$A_2 - 2\sqrt{3}\ E\ J \cos (\phi + 30),$$

and the two meters read the same value. If the right-hand coil in place of the left-hand one were incorrectly connected, the sum of the readings would be

$$A_3 = 2\sqrt{3}\ E\ J \cos (\phi - 30),$$

but the two readings would again be equal, whatever the angle of lag. When the power factor is less than 1 (current lagging), A_2 is less than the true watts, A_1—*i.e.*, the Fig. 2 connection favours the consumer—whilst A_3 is greater than A_1.

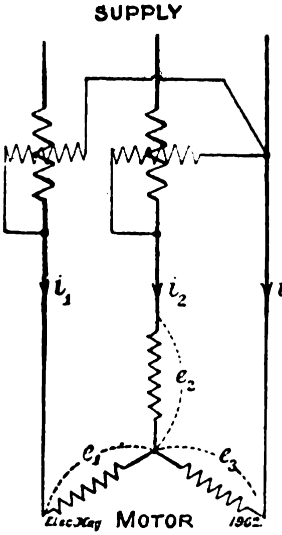


FIG. 1.

Calling the percentage error with the Fig. 2 connection $f_2 = \frac{A_1 - A_2}{A_2} \times 100$, and the percentage error with fault in the right-hand instead of the left-hand coil $f_3 = \frac{A_1 - A_3}{A_1} \times 100$, the following table shows the results obtained:

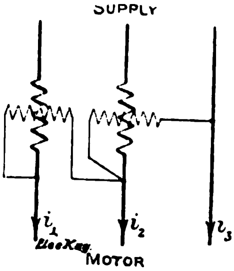


FIG. 2.

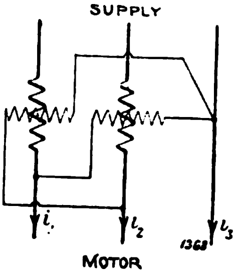


FIG. 3.

Angle of phase difference ϕ.		Cos ϕ	f_2 too little.	f_3 too much.
	0	1	0	0
Lagging current	30°	.87	+ 33%	+ 33%
	60°	.5	+ 100%	+ 100%
Leading current	−30°	.87	− 33%	− 33%
	−60°	.5	− 100%	− 100%

When the faulty connection shown in Fig. 3 is employed, the sum of the readings in the two possible cases is

$$A_4 = \sqrt{3}\ E\ J\ (\sin \phi + \sin \phi) = 2\sqrt{3}\ E\ J \sin \phi,$$

or

$$A_4 = \sqrt{3}\ E\ J\ (\sin \phi - \sin \phi) = 0,$$

i.e., either zero, or a value proportional to the wattless current. The readings on the two wattmeters are, however, again equal, in contradistinction to the correct case (Fig. 1), where they are never equal on ordinary circuits owing to phase difference between E and J.

◆

Some Motor Breakdowns.

THE occasions on which the motor inspector of an electricity department is called in to attend to stoppages and breakdowns, from comparatively simple and frequently unavoidable causes, must be many and troublesome. In his annual report to the British Engine Boiler and Electrical Insurance Company, Mr. Michael Longridge gives a number of instances of breakdowns dealt with by his staff of inspectors, which are worth putting on record. Perusal of a few may give an inspector points which will perhaps save him much needless and often fruitless search in other directions.

A four-pole shunt-wound motor, rated to take 45.5 amperes at 460 volts and running at 625 revolutions per minute, had been stopped on account of sparking, excessive heating of the armature, and the dropping out of the automatic overload circuit breaker, which was set at 70 amperes. Seeing no defect about the machine externally, the inspector attempted to run it, but found that although the speed was practically normal the current taken was so excessive that the automatic circuit-breaker would not stay closed, and finally the fuse, consisting of eight No. 30 S.W.G. copper wires, melted.

Having convinced himself that the motor could not run, he made a more minute examination, and finally discovered a bad contact between the negative supply cable and the main terminal on the machine, due to slackness of the terminal nut. He tightened the nut and started the motor again, when it ran quite satisfactorily. The trouble was due to the fact that one end of the shunt circuit, as well as the negative brush lead, was connected to the terminal with which the negative supply cable was making faulty contact. Although at first sight it is not obvious why a resistance introduced into the main circuit of a motor should increase the current taken and not affect the speed, yet a little consideration will show that it must be so. For, whilst the voltage across the armature is reduced, tending to reduce the speed, the shunt current is also reduced in the same proportion, weakening the field and tending to increase the speed. The two effects nullifying each other, the speed remains unaltered, but that the motor may continue to drive its load the current must be increased to make up for the reduction of the voltage through the resistance of the faulty contact. Judging from the melting point of the fuse, about 100 amperes, the voltage must have been reduced by about 50 per cent. A loose contact on a fuse terminal on a motor circuit will produce the same result, and the melting of fuses attributed to the heat generated by imperfect contacts is in many cases due partly to the passage of excessive currents caused in the way described.

A four-pole shunt-wound motor, running at 1500 revolutions per minute, and taking 12½ amperes at 230 volts, controlled by a main switch and a starting-resistance switch fitted with automatic no-load and overload release coils, was broken down. On arrival at the works, the inspector was informed that the motor could not be started because the fuse melted whenever the main switch was closed. A glance at the position of the lever of the starting-box showed that the resistance was cut out of circuit, so that closing the main switch put the motor armature directly across the supply mains. The lever had been fitted with a coil spring, but it had become so stiff from neglect that it had not sufficient force to throw the lever back when released by the no-load coil. It consequently remained in the position in which it had been left the last time it had been used for cutting out the resistance coils of the starting-box. A little cleaning and a drop of oil by the inspector put matters right.

A series-wound 8h.p. motor, taking current at 200 volts, and connected by a coupling on the end of the armature shaft to the hoisting motion of a crane, broke off its armature shaft at the shoulder against which the coupling abutted. The shoulder was quite square to the shaft. The fracture started in the square corner all round the circumference, and gradually ate its way inward till the sound core became insufficient to bear the stress upon it. The weakening effect of abrupt changes of section and sharp notches in shafts is duly appreciated by most makers of steam engines, but makers of dynamos and electric motors seem quite indifferent to it; yet, considering the enormous number of alternations of stress in a given time on the shafts of these machines, one would think that every possible device would be resorted to to minimise their effect. Considering that these small shafts often make from three to four million revolutions per week of fifty-six hours, it is wonderful that they live as long as they do.

A series-wound 30h.p. motor, taking current at 400 volts, had an armature core carried on a gun-metal spider with three arms threaded upon a steel shaft three inches in diameter with a feather key and secured against a collar at one end and by a nut 1¼in. thick and 3¾in. over the flats at the other. The commutator segments were carried on a gun-metal quill, having a collar at one end and a nut at the other in the usual way. The quill was held against a shoulder on the armature shaft by a nut at the outer end, and prevented from turning partly by the friction of the nut and partly by an iron peg $\frac{3}{16}$in. diameter stuck into a radial hole in the shaft and projecting $\frac{3}{16}$in. above the surface to engage in a short keyway cut in the inside of the quill.

Owing to low insulation, the commutator was taken off in order to test the armature conductors, when the peg referred to was found partially sheared through, the nut for securing the armature spider off the screwed part of the shaft and hanging loose upon the plain part between the end of the screwed thread and the commutator quill, and the keyway in the spider worn ¼in. wider than the key. Both armature and commutator being loose upon the shaft, breakage of the end connections and destruction of the insulation by rubbing might be expected.

The Machinist and The Emergency.

The following incident illustrates the value of knowing what to do promptly in cases of emergency. The particulars are given in *Power* by Mr. G. P. Pearce.

The other day there came to my notice an incident which may be of interest to your readers, it being an illustration of the value of presence of mind.

In a moderate sized power-house one of the 1000h.p. cross-compound Corliss horizontal engines, which was directly connected to a generator and running in parallel, suddenly started pounding and hammering as though it were going to pieces. The engineer rushed for the throttle and was on the point of shutting down, when a machinist, who was working on the next engine, rushed up and said, "Don't shut down; you'll throw too big a load on the other and raise Cain," and before the engineer could speak he jumped to the high-pressure cylinder, and quickly taking a wrench out of his pocket, shortened the reach rod to the head-end inlet-valve, so that it did not open to admit steam. The noise instantly ceased, and the governor fell a little, but quickly picked up as the other generator took over a portion of the load. The machinist then went over to the low-pressure side and, turning the right and left-hand nut on the governor rod, lengthened it, causing the valve to close early, thus increasing the initial pressure and throwing more work on the low-pressure side. At the same time he yelled to the astonished engineer to start up another engine.

In about five minutes another generator was running and took up the load from the first engine, which was now shut down. The machinist then explained to the engineer that the cause of the trouble was the key which holds the rocking lever on the head-end exhaust valve. This had fallen out, leaving the exhaust valve closed, and thus trapping the contained steam and causing the rumpus. He had seen the cause of the trouble at a glance, and so cut off the steam admission, making the engine single-acting on the high-pressure side. By regulating the low-pressure cylinder to approximately balance this new condition, he made the engine still carry a considerable load, thus saving the full load from being thrown on the other generator, which would probably have overloaded and thrown open the automatic switches and shut off all the power.

Getting New Business.

The American central station is now being run on strictly commercial lines and special advertising men are engaged to conduct the business campaign. The general tone of the methods adopted will be understood from the following abstracts from a paper recently read by a central station "development" manager.

An advertisement, of whatever kind, should do four things: first, attract attention; second, arouse interest; third, create desire; fourth, bring about resolve to buy. This is true of the article which, once sold, the seller has nothing more to do save to wish to repeat the sale of the identical article. It is true, so far as it goes, with writing an advertisement for gas—only the organization above referred to permits of the effect, whatever it may be, being followed up more completely.

Suppose the prospect has a mind which isn't logical enough to follow your advertisement through the "resolve to buy" stage, or suppose your advertisement isn't sufficiently logical or strong enough to bring him there. Suppose you have only attracted attention or aroused interest. Your solicitor comes along. He already has an opening. He is more liable to get a hearing. He is still more liable to, if you have so shaped your advertisement as to make that opening for him.

We have, then, exploited our product to the extent, at least, of making an opening for the solicitor.

LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

The Need for the Illuminating Engineer.

By LEON GASTER.

THE recent comments published in this journal dealing with the necessity for the professional illuminating expert, and your kind invitation to express my views regarding this subject, are my main reasons for sending you the following article.

Until recently insufficient attention has been given to the systematic application of the scientific principles of artificial illumination, the degree of illumination desirable for different purposes, and the disposition of light sources for artistic effect. All these have been mostly ignored, or to say the least, on account of lacking exponents, have not been accorded the prominence due to them. The different purposes for which artificial light is required call for special treatment if the best results are to be obtained, and it is therefore regrettable to note that in many cases recourse has been had, for effect, to extravagant illumination without due regard to expense, or the effect on the eyes from the glare. The reverse has happened in other cases, so that little light has been used on account of cost, and even that has not always been turned to the best advantage.

My object in writing this article is not to make a wholesale complaint, but if possible to indicate how in time to come, this deserved reproach of neglect may no more be justifiable. Considerable work has already been done by several investigators *re* the absorption and distribution of light from shades, globes, and reflectors. The data obtained on this subject are, however, very much scattered, and no uniformity exists in the results of the reported tests. The great variety of systems of photometric measurement and apparatus used by the different observers explain, to a certain extent, the reason for these differences. The value of engineering data of this kind lies largely in their use for making comparison of one reflector, shade, or globe with another, and it is therefore gratifying to find that recently Messrs. J. R. Cravath and V. R. Lansingh have drawn all their data, published in their admirable articles *re* reflectors, shades, and globes in the *Electrical World*, from tests made in a single laboratory. The results of these tests are therefore of great value for comparison. The immediate practical application of the data given is evident, when one considers the great improvements which can be obtained in planning illumination by incandescent lamps, by knowing what types of reflectors, shades, and globes have to be selected, so as to change the natural distribution of light from the bare source for the accomplishment of a desired effect. In examining many of the existing installations, one is often struck by the awkward position in which the lamps are placed, which can hardly be traced to the former use of gas and gas fittings.

In order to advance and discriminate the knowledge relating to the science and art of illumination, as has already been announced in this magazine, an Illuminating Engineering Society has been established in New York, which was formally organized at a meeting on the 10th of January, 1906, its first president being Mr. L. B. Marks, and its secretary Mr. E. L. Elliott. The Society started with about 89 members, but now it is estimated to consist of over 200. The objects of this society are to co-operate with other bodies having an interest in securing the best results from the various illuminants. Such society is expected to accomplish an admirable purpose, both directly and indirectly, through its papers, exhibitions, and discussions, and by the bringing together and co-ordinating of the now widely scattered knowledge on the subject, and extending it by recording data and by furthering the systematization of practice. The society is to embrace, naturally, the different illuminants and will contribute largely in furthering the interests of the lighting industries, electric, gas, and oil.

Much has been done by central station engineers to bring down the prices at which electrical energy can be generated by adopting improved methods of power generation. Although there is still a great possibility for further reducing the price of the current in the future, the immediate economy to the consumer, however, lies in properly studying the selection of the most efficient type of lamps, by the careful distribution, and by a selection of shades and reflectors, and for this purpose the future illuminating engineer can come to his assistance. The present gap which seems to exist between the supply authorities and the consumer demands the creation of a distinct illuminating engineering profession which will be expected to make a special study, not only of the merits of electric lighting, but be also well acquainted with the merits and faults of the other systems of illumination. Only from such experts can one reasonably expect unbiased opinions as to the best systems of lighting to be adopted. Very often one is confronted with the problem of deciding whether gas, oil, or electric light is best to be employed, and only by properly studying the circumstances of the case, viz., the price per unit of electric energy charged, that of gas or oil, and the purposes for which the light is to be utilized, &c., is one in a position to decide what system would be best and most economical to adopt. For the present it is hardly possible to find that expert engineer of whom we are speaking now, because he is, as a rule, either interested in electric lighting or in pushing the gas interests, and we find that according to his inclination he may be biased in his decision. Moreover, it might appear in a good many cases that a combination of two systems would prove economical. Such cases have frequently come before my notice, one part of the work using gas, and the other using electric light, but it is difficult to find at present the engineer to recommend the use of both systems.

Gas engineers have nursed their consumers much more by looking after the lighting business, greatly extending the use of mantles, and have made the gas lighting what it is. There is, however, I believe, still more to be done in this respect by gas engineers. Some think that great economies are to be derived in the future from further improvements in the manufacture of gas, and from the gas companies being relieved of the duty of producing gas of specified c.p. They would prefer to use the gas as a heating agent, and, indirectly, for lighting purposes, as in use of gas mantles. Then gas would be cheaper, and it would find more extended use also for heating and motive power purposes.

(*To be concluded.*)

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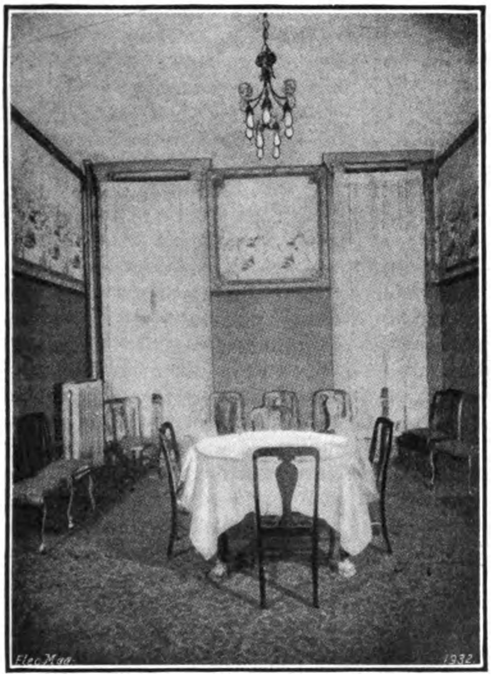
Correct Lighting of Rooms.

WITH the growth of illuminating engineering will come the collection of valuable data on the proper use of artificial illuminants. Things just now are done very haphazard, and no special motive appears to prompt the placing of lights here or there as the case may be. While one cannot advocate strongly that definite rules and regulations be strictly observed, or the art of illumination reduced to the mere mechanics of the thing, obviously some principle must be laid down and effort made to work generally upon it. In previous issues we have referred to the excellent articles by Messrs. Cravath and Lansingh, in the *Electrical World*, on the subject of reflectors, shades, and globes. These illuminating experts have just completed another series of articles in our contemporary, on the subject of room lighting, and for the benefit of interested readers we give an epitome of the scheme, which was elaborately treated, and illustrated with views of typical examples of good and bad lighting. On the subject of the reading lamp the authors are very emphatic. They deprecate the flooding of a room with light when only a moderate amount is needed, and point out the disadvantage of a constant glare which tires the eyes and affords no relief in the



An Example of Wasteful Illumination.

way of darkened parts of the room. On grounds of cost, also, this practice is very wasteful. The opposite extreme is just as bad, in that the concentration by reflectors of the light on the spot needing it leaves the room in darkness, and necessitates another lamp and switch if something is needed in the room. The compromise recommended is a lamp, on the wall preferably, above the reader's chair, and fitted with a reflector concentrating the greater part of the light on the book or paper, and diffusing the remainder into the room. Portable table lamps are not recommended, as being an inheritance of candles and oil, the only thing stated in their favour being the absence of "glare" on a white page of paper, such as is met with from bracket and chandelier lamps. The table lamp throws its rays from the side, and there is not the least difficulty in reading a white page at any angle. A misconception of the distance between the reader and a portable light, and a chandelier 6ft. above the table, is pointed out, the contention being that the table lamp is not as near the object as is commonly supposed.

Taking up the question of room lighting, it is stated by the writers that "in the general lighting of a living or reception room where a number of people are likely to be around in positions facing the chandelier, it is important to avoid anything which would allow the undiffused rays from a large portion of the bare filament to fall on the eyes. Whenever open reflectors are used they should be equipped with frosted bulb lamps." Dealing with small dining rooms, it is argued that the concentration of the light from a single pendant over the table, on the white cloth, will give the desired illumination where most needed, and ensure sufficient reflection into the room to provide ample light. The principle enunciated is: "Have the table well lighted and the room will take care of itself." Attention is drawn to a common, but highly unsatisfactory and wasteful, method of lighting a dining room, and of this we give an illustration of the example taken. It will be noticed that a cluster of nine lamps is placed near the ceiling, which is apparently relied upon for reflection, but for that purpose is very inefficient. Half the lamps could be used, if suitable reflectors were employed, and a material saving effected. In an example of this kind the height of the lamps admits of the use of plain bulbs, and, further, with the suggested reflectors, sufficient general illumination is secured, while the bulk of the light is concentrated on the table.

The bedroom lighting problem is regarded as one of the most difficult if really effective illumination is desired, and in the event of a desire for economy compromises are suggested which give a fair approximation to the ideal. It is stated that fully six lights are needed in different positions, say, one for general illumination, three for the dresser and mirror, one over the bed, and one in the cupboard if this be large. The essence of economy is touched by the suggested employment of a central point from which a portable lamp with ample length of flexible is hung and taken to any part of the room. Obviously a wind-up ceiling rose would be useful in this capacity, but it is not suggested. A slightly more expensive method is the use of a central lamp, and the provision of a number of plug sockets at various points, admitting of connections at desired points. In a near issue we shall deal further with this subject.

Illuminating Engineers
anxious to witness the early formation of an Association to foster your interests, write us without delay.

Train Lighting.

THE electric lighting of at least main line railway trains is now generally recognised as the safest and best method of illumination. Opinions differ, however, as to the more suitable system of generating the necessary energy out of two from which selection can be made—a separate dynamo on each coach, and a turbo-driven unit on the locomotive. The separate dynamo method is in more general favour, and has much to commend it, but on grounds of simplicity it cannot be favourably compared with the single generating unit. A short description of typical examples of both systems will enable this comparison to be readily made.

Taking the separate dynamo arrangement first, a typical system may be examined in the Leitner-Lucas, the diagram of connections for which is shown in Fig. 1, taken from the *Railway Gazette*. When starting up the terminal D′ is positive, and D negative, the voltage between the two assisting that at the main brushes in exciting the field, which builds up rapidly. At the same time the current leaving the armature at GG′ increases and also increases the armature flux in the direction of GG′, thereby reducing the original voltage between DD′, and subsequently reversing it. With the rise in the armature speed the voltage between DD′ increases and opposes the shunt current, neutralizing its influence, and giving an automatic control over the armature voltage. The small coil G^3 is in series with the lamps, and is energised as soon as the load is switched on. Its effect is to render the field excitation more positive, though it is not absolutely necessary. An accessory of the system is an automatic device for switching in the battery when the train comes to a standstill, and the connections of this are shown in the diagram. Fig. 2 is a set of curves showing the relation of current and voltage to train speed, and graphically depicts the performance of the dynamo, clearly illustrating how it fulfils the claims made for it. As we have already said, each coach must have its own "plant," which includes a battery for standing supply, representing considerable dead weight throughout the train.

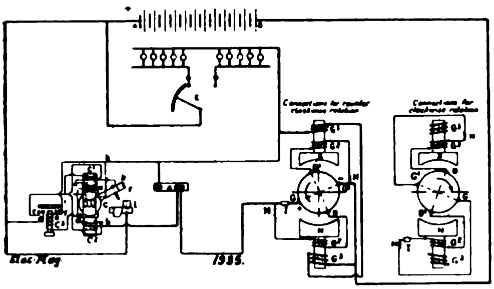


FIG. 1. DIAGRAM OF LEITNER-LUCAS TRAIN-LIGHTING SYSTEM.

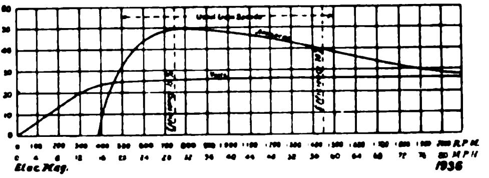


FIG. 2. CURVES SHOWING RELATION OF SPEED TO OUTPUT OF LEITNER-LUCAS DYNAMO.

With the separate turbo-unit on the locomotive matters are very much simplified. The use of a simple rotary engine to drive the dynamo relieves the driver of all responsibility, and ensures a constant supply of energy for the entire train. In Fig. 3 a 15kw. train lighting turbo-set is illustrated, as ready to fix on the crown of the locomotive boiler alongside the steam dome. The method of mounting is clearly shown in Fig. 4, the locomotive being of American pattern. The dynamo in this case is a two-pole machine-wound for from 85 to 125 volts, according to requirements, and made up in three sizes, 15kw., 20kw., and 25kw. The 15kw. set runs at 4000 r.p.m., and weighs complete 1850lb., the dimensions being 66in. by 22in. We understand that they are largely used in the United States, and it is not uncommon to place the little unit in the luggage van, coupling it up to the locomotive by a flexible steam pipe. When exposed on the locomotive boiler to all weathers the dynamo is completely enclosed and carefully protected from damp.

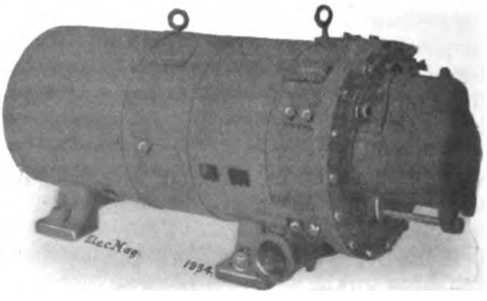


FIG. 3. A 12KW. STEAM-TURBO TRAIN-LIGHTER.

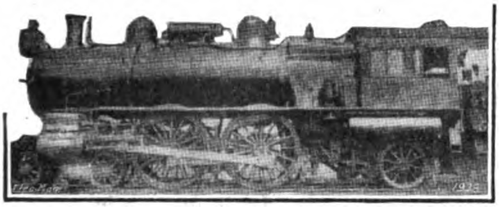


FIG. 4. LOCOMOTIVE WITH TURBO-DYNAMO MOUNTED ON BOILER.

Very little discrimination is needed to perceive where the advantage in the matter of weight lies in comparing the two systems. The tiny turbo-generator will weigh less than the equipment of a single coach, and the hauling of a mass of dead weight is thus removed from the locomotive. We have not yet seen any figures published comparing the economy of the respective systems, but there must certainly be considerable saving in the capital outlay.

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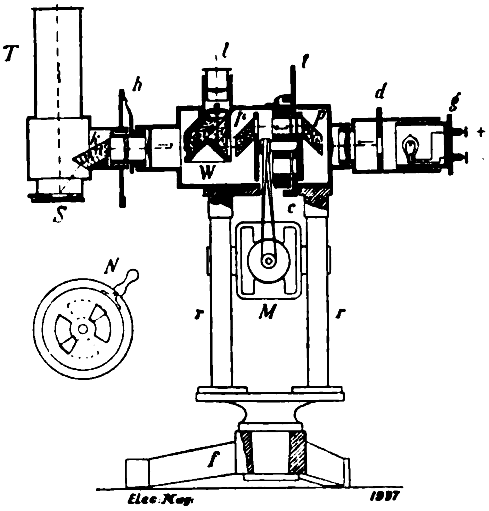
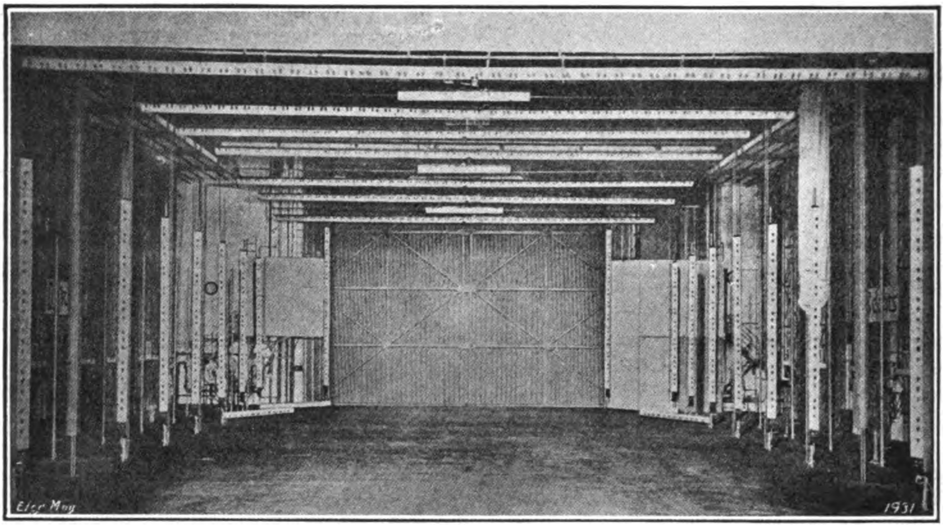
A Novel Photometer.

OUR friends the Germans are endowed with the scientific spirit, and possess a patience in the conquest of minute detail which is certainly beyond the average Britisher. This compliment to our somewhat heavy neighbours is strikingly illustrated in the design of a photometer which is the result of investigations by Dr. L. Bloch in the field of light measurement. It was recently described in *Elektrotechnische Zeitschrift*, and a translation, with numerous illustrations, was published in the *Electrical Review*. By the method employed, use is made of two instruments—a spherical shell enclosing the light to be measured, and the photometer proper. With the apparatus it is possible by one observation to obtain the value of the whole amount of light emitted by any source, without relation to light distribution in different directions. The general theory, to quote our contemporary, is as follows: "When a source of light is placed inside a spherical shell having a matt surface, the light received by any part of the interior surface can be divided into two parts: (a) the light received directly from the lamp, and (b) the light received from the remainder of the interior surface of the sphere after one or more reflections. The quantity (a) is that which is measured in the usual photometers, which determine the intensity of the light emitted in one direction, and is not considered at all in the Globe photometer. By the theory of the Globe photometer, the quantity (b) is constant all over the surface of the shell, and is proportional to the total amount of light emitted by the lamp, quite independently of its position in the shell."

In the adjoining figure is shown a section through the photometer itself, and an examination of its structure will at once bring out the force of our opening remarks. Referring to the lettering, S is a plaster of Paris plate with a matt surface illuminated through the tube T by the light under measurement. From S light is reflected through prism K, lens *h*, and prism W into the eye-piece *l*. From the opposite end light is received through opal screen *d*, prisms *pp* and prism W also to the same eye-piece *l*. The prism W is divided on its oblique line, and only a small elliptical area of the two parts is in optical contact. Through the eye-piece is viewed a central circular area illuminated from *d*, and a ring enclosing it illuminated from S. The amount of light from *d* can be regulated by moving the handle *t* carrying a disc having openings such as shown in plan at N. The prisms *pp* are driven by a small motor, and if no screens or diaphragms are interposed, the light from *d* will fall continuously on W after four reflections through the two prisms, notwithstanding the rapid rotation of the system. The illuminating effect of a rapidly intermittent light is proportional to the time it is seen, and is



SECTION THROUGH SPECIAL PHOTOMETER.



View of the Stage Lighting by Special Fittings, in Stadt Theatre, Nürnberg.

independent of the mode of intermission, if the intermissions are rapid enough to be imperceptible. By the adjustment of *t* the light passing from *d* to W and the consequent brightness of the central area seen in the eye-piece can be regulated in a proportion read exactly by the scale of *t*, and independent of the motor speed. It will be seen then that this type of photometer compares two sources of light, not, as is usual with other photometers, by adjusting their relative distance from the observing apparatus, but by rapidly interrupting one of them in a determined way until they appear equally bright in the observation eye-piece. In practice the instrument has, we understand, proved very satisfactory and convenient.

Lighting Notes.

The above illustration shows the general arrangement of the electric stage lighting equipment of the City Theatre, at Nürnberg, Bayern, Germany, as recently installed by the Siemens-Schuckert Werke, of Berlin. There are nine sections of vertical lamps on each side of the stage in three colours, each section having a wire guard and provided with switches at the base for separate control when desired. The overhead hanging lights are mounted in frames, with sprocket chains and pulleys for adjusting to any angle. There are seven of these sections extending the whole width of the stage overhead, and several shorter sections, as indicated in the illustration. The lamps are all arranged in groups of three colours, each of thirty-two candle-power, operating on 250-volt circuit. The footlight section is also provided with guards and mounted in frames. Portable reflectors are also provided, mounted on tripods, with twelve and twenty-four lamps in each section, arranged in rectangular form and also in circular frames.

* * *

It is better to use lamps with large glass bulbs, as the internal blackening process is thus spread over a greater area and is therefore thinner, presenting less obstruction to the light. This view is confirmed by the rapidly increasing use of lamps with large spherical bulbs which do not reveal the blackening process nearly as quickly as ordinary-sized glass bulbs. — G. Wilkinson, Leeds I.E.E.

* * *

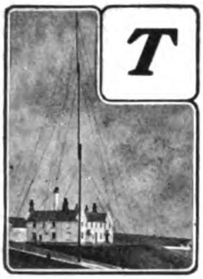
The Chicago Edison Company has found by experiments that the use of smaller carbons in its street arcs greatly increases the light given, reduces the energy consumption, and provides a steadier light. Compared with $\frac{1}{2}$in. carbons in a 3.5 ampere lamp a $\frac{5}{16}$in. carbon reduces the energy consumption from 3.4 to 2.2 watts per candle. A life of 100 hours is obtained, and the gain in light is stated as 50 per cent. With the larger carbons inner globes needed trimming every seventy hours or once between each trimming, but this is not now necessary.

TELEGRAPHY & TELEPHONY

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

The Telephone System of the Future.

By LE ROY W. STANTON.



Three distinct types of telephone equipment have been developed—the magneto or local battery, the common battery or lamp signal, and the automatic. The first two may be further subdivided into the transfer and multiple systems. At the present two telephone systems are being developed which are the outgrowth of the systems mentioned above. One may be called the transfer or trunking system, and is applicable only to large cities. The other, the semi-automatic, is applicable not only to large cities, but to smaller cities and towns. Now the still greater increase in number of telephones has carried the capacity beyond that of the multiple switchboard, thus making necessary the establishment of branch exchanges with trunk connections. This growth has increased to such an extent that in some of the larger cities a score of branch exchanges are required. When a development so great as this has taken place, a large percentage of the originating calls in any one of the exchanges is for a subscriber in some exchange other than the one originating it. For this reason the subscriber's multiple, which is placed within reach of the A or originating operators, is used but very little, often ninety per cent. of the calls being trunked to other exchanges. In such a case an expensive part of the central office equipment has an efficiency of only ten per cent. and is not fulfilling the requirement for which it was intended, namely, that of eliminating the extra operator in making a connection between two subscribers.

The present tendency in large cities is to eliminate the A subscriber's multiple and treat every call as a trunked call. While this system is gaining favour over exchanges with the multiple system as used to-day in leading cities, it is far from being as economical in first cost or in operating expenses as a system which may be called the semi-automatic. Such a system, generally speaking, embodies the valuable principles of both the manual and the automatic. It eliminates a good number of the operators who are found in the manual system, and avoids the complicated mechanism found in the automatic system. It utilizes the telephones at the present time employed in the manual common battery system. Its operation is briefly this: a subscriber, upon lifting his receiver from the hook, operates in the main office a line relay similar to that used in the modern lamp signal board, but this, instead of lighting a line lamp, energizes a simple selector-switch which selects an operator who is not busy and, in turn, selects a connecting cord which is not busy and lights the lamp associated with this cord. The current lighting this lamp passes through a low-wound relay, which connects the operator with the subscriber. Upon receiving the number of the instrument wanted, the operator inserts the plug in the multiple and rings. Upon inserting the plug in the jack, the cord-lamp is automatically extinguished and the operator's listening set is disconnected at the same time, leaving the two subscribers to converse in privacy. This action also leaves the operator free to receive another call.

When the subscribers finish their conversation and restore their receivers to the switch hooks, the lines are automatically disconnected. This leaves the line free to receive other calls or gives the subscribers opportunity to call again immediately. It leaves the plug in the jack until the operator removes it, but the automatic disconnecting of the two subscribers leaves this cord and plug dead. The busy test is taken off the multiple jack, and the disconnecting lamp signal corresponding to the cord used is lighted, thus notifying the operator to take down the connection.

With such a system an operator would be constantly busy, and since she would never be overloaded nor ever idle, the service would be prompt and uniform. She can receive only one call at a time, due to the automatic distribution of the calls to any one operator. The subscriber, upon lifting the receiver from the hook, automatically is put in talking connection with the operator, who gives the number desired without waiting for a request. The operator repeats the number and glances at the keyboard, noting the lighted lamp which indicates the cord to be used in making the connection. Owing to the fact that she would not be required to use an answering cord, listening key, or ask for a number—operations which take up the greater part of her time—and owing to the automatic selections, she would probably answer three times the number of calls usually attended to by an operator under the present system in the same time. For night service, Sunday service or at other times when the load is light, the number of operators can be reduced. Owing to the fact that the first few operators receive all the calls, the last positions are only brought into service during the rush hours.

The system just outlined is especially applicable to towns and small cities. By means of a slight increase in the equipment an additional advantage is gained through automatic trunking and branch exchanges. In such a system automatic trunking equipment is used in the branch exchanges. A subscriber, upon lifting the receiver from the hook, operates a simple line relay in the branch office, which, in turn, operates a selector, which selects a non-busy trunk to the main office, whereupon the operator would be selected as described above. The operator, instead of making connections in the multiple, makes connections in an outgoing trunk, which terminates in the office to which the subscriber called for is connected. The operator at the central office is required to operate an ingeniously designed key, which selects the subscriber called for. Such a system not only increases the capacity of the plant very decidedly, but eliminates all of the trunking operators and a large part of the A operators. It also eliminates the multiple, answering jacks, line lamps, one-half the cords and plugs, and the intermediate board. The line relays are still necessary, and, in addition, a simple device for selecting the position and cord to be used is required. By using branch offices with the trunk selectors the cost of the outside plant may be greatly reduced. One trunk for every ten subscribers would be sufficient for carrying the business between the main and the branch offices. The apparatus at the branch office is a simple one-motion selector which would select a non-busy trunk to the main office. In calling the subscriber there will be an additional motion required of the selector, which will be simple, owing to the fact that there is only a small number of subscribers entering any one of the branch exchanges. By having small exchanges there is but a small number of subscribers to select. Thus a simple indicator suffices. Further, the wire mileage is reduced owing to the small area served by each branch exchange. Such a branch office may be installed in any suitable, inexpensive location—either in a building, in a special terminal box, or on a pole.

The system, as here outlined, makes use of the simplest known form of substation equipment. It effects a large saving in the outside wire plant, it eliminates most of the objectionable features of central office equipment as found both in the automatic and manual systems, and it furnishes a superior service, since it is more rapid than either the manual or automatic. Further, it makes it unnecessary for the subscriber to operate a mechanism and thus make his own call. The subscriber is not subject to delay due to a busy operator, and, moreover, the service is secret.—*Electrical Review*, N.Y.

* * *

Don't Spend Shillings where Pence will do.

The ELECTRICAL MAGAZINE, is Good Value for Sixpence . . .

Why Spend More?

Letter-Telegrams.

WE frequently hear it stated that the day of the telegraph is practically gone from the standpoint of public service, and that the telephone will at no distant date take its place. Few, however, realise that present-day telegraph wires are worked at about only one-fifteenth of their capacity because of rigid adherence to semi-automatic and hand methods. Labour and time-saving devices have successfully supplanted older manual processes in other industrial spheres, and it only remains to introduce the automatic element on a general scale into telegraphy to at once vastly increase the traffic over existing lines. Mr. R. Hitchcock made out an admirable case for the auto-telegraph recently in the *Telegraph Age*, and his arguments are worth quoting at some length. He says: "While the importance of increasing the working capacity of wires has long been recognised, it is to be noted that progress in this direction has been mostly confined to means of increasing the messages over one wire by a number of operators using the Morse key, to the neglect of the more important problem of attaining the highest speed of signalling. Consider the bearing of this fact on the capital investment; a wire costing £6000 is capable of carrying 1000 words a minute, but the practical limit of quadruplex hand sending is sixty words. Moreover, along with this increase in transmission speed there is certainly a doubling of the efficiency of the operating force, and an accuracy far beyond that of manual operation."

After referring in eulogistic terms to the use of the Wheatstone in this country as an adjunct to key working, the writer goes on to say that "A rapid automatic system cannot be properly utilized if made supplementary to hand methods. The cost of a nation's telegraphs is determined by the expense of the prevailing methods used. The full benefits of automatic working can only be enjoyed when all economies are utilized. Wherever the volume of business offered exceeds the carrying capacity of a wire operated by hand methods, it is much cheaper to add a set of automatic machines than to construct and maintain an additional wire.

"So long as the telegraph administration aims to give the least possible service for the highest price it can exact from patrons there will be no need for high-speed methods. But the situation changes when we consider the effect of the great reduction in charges which rapid automatic operation renders possible. The immediate effect will be an incalculable increase in the volume of business offered. To assume that if prices are reduced to one-tenth, ten times as many telegrams of fifty words each will be sent as of ten-word telegrams now is a conservative estimate.

"Those who regard the telegraph as necessarily an expensive emergency service rather than a possible public utility and convenience, will scarcely be prepared to credit the cheapness of automatic methods. Since the cost of a message is determined by the volume of business carried by a wire, the relative costs of telegraphing by different methods depend primarily upon the item of transmission. For clearly the cost of preparing messages on tape for machine transmission, and of transcribing them at the receiving station, cannot enter as a prime factor in the comparison.

"In the ideal automatic system it is not necessary that this service should be rendered by the telegraph company. It can, and undoubtedly will be, done principally by typists and stenographers in private business offices, the telegraph corporation being only the transmitting agent of correspondence thus privately prepared, no word of which becomes known to the telegraph operators. Thus the telegraph charges would be for transmission of messages only, and all messages thus prepared are absolutely private and secret.

"In the light of the remarkable changes brought about within a generation in the world of varied activities, one cannot predict the effect of high-speed telegraphy upon daily social and business correspondence. To say that it is destined to be mostly carried by electric impulses over wires, leaving but a comparatively small proportion, the most voluminous and heavy, to follow as letters on railway trains, may seem wildly fanciful, incredible. Perhaps it is so. But does anybody know? Would not the benefits of quicker communication be universally felt? And when once recognized would they ever be relinquished? The whole question is one fundamentally of practicability and costs."

Telephones in Berlin.

The telephone system at Berlin is a branch of the Imperial Postal Service and is administered throughout by employees of the Government, who hold their positions for life or during good behaviour, and receive pensions when they finally retire by reason of old age or disability. The service has grown to one of the largest in the world, not less than 86,000 telephones being now installed in the public system of Greater Berlin. The long-distance telephone service embraces within its scope more than 2600 cities and towns in Germany and other European countries, including capitals like Paris, Brussels, Rome, Vienna, and St. Petersburg. For this branch of the service the central telephone bureau is equipped with a staff of operators, mostly women, who are competent in the various European languages. The short-distance service includes the city of Berlin proper, which is divided into nine districts, each with its central exchange, and 18 branch exchanges in the various suburbs within a radius of five miles from the central station in Berlin.

The cost to subscribers per annum for a telephone installation in Berlin is from £8 to £9 per annum, while for certain suburbs where the instruments are less frequently used, the cost varies from £4 at Aldershof to £6 at Steglitz, and £7 at Westend, which is the extreme western section of Charlottenburg. The largest number of instruments embraced in one district or exchange is in district or "Amt" I., with 13,538 connections; next comes Amt IV., with 12,884, and III. with 10,503. In the organisation of the various exchanges one female operator attends to the calls of from 100 to 200 telephones. The operators are carefully educated and selected, ably directed, and are for the most part alert and efficient. At all the branch post offices and district exchanges as well as at various other prominent places throughout the city are prepayment public telephones which any person may use after dropping in the slot a 10-pfennig piece, the value of which is 1¼d. in English currency.

The rates for long-distance service are as follows for a three-minutes conversation. The following schedule includes only Germany: To all places within a radius of 15 miles, 2½d.; 30 miles, 3d.; 315 miles, 1s.; 625 miles, 2s.

The rates for telephone service to foreign countries are specially arranged with the Governments of the several neighbouring nations and are relatively higher than those between points within the German Empire.

Telegraph and Telephone Notes.

China does not boast a telephone exchange, but there is such a commodity run by Chinamen and used by them, though not in the land of the Forbidden City. The Chinatown district of San Francisco contains the world's only Chinese telephone system, at least so our contemporary *Telephony* would have us believe. As long as ten years ago Chinatown had a few telephones, but to-day it is proud of a 900-line exchange and will shortly put its overhead wires beneath the ground. In three years the business has increased 200 per cent. and of the 1000 merchants some 700 have telephones. The system is also linked up to the trunks, but for the privilege of intercourse Chinese and Christians must pay a special toll. There are so many dialects spoken that numbers are not always given distinctly, and it has been the practice to ask for names instead, but this will shortly be done away with. The operators are specially selected for their linguistic ability, acuteness of hearing, memory and clearness of voice, all highly desirable when one considers that, apart from other languages, some eighteen dialects in Chinese, all differing widely from each other, have to be understood.

* *

Primitive as we are accustomed to supposing the east coast of the Adriatic to be, says Felix J. Koch in *Sound Waves*, the network of telegraph is fairly complete, and in Istria, at every railway station, as in America, the operator is installed. There, and in Montenegro, like the post-office, the telegraph is a Government institution. Even little Montenegro has its wireless telegraph system, owned by the Prince himself, at Antivarri, where the Grand Cordon of Montenegro was conferred upon Signor Marconi. At Buda-pest, in Hungary, the newspapers one and all publish the same telegrams from outside, and such a thing as "scoop," or "beat," is unknown. Hence, much of the necessity for haste in journalistic telegraphing, that is so apparent with us, is there obviated.

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

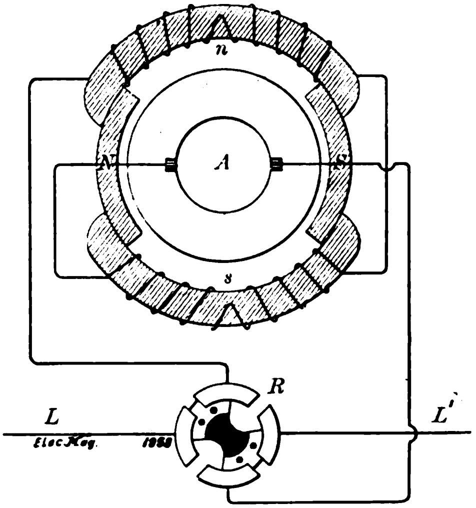
The Reincarnation of an Electrical Idea.

By FRANK J. SPRAGUE.

It is a curious circumstance that there should have been recently resuscitated and put into a practical working form, a method originally developed for the same purpose, and then, like many other good things, for the time being laid aside in the march of development along other lines. This particular instance is one of the most curious with which I am acquainted, and illustrates the fact that no thoroughly good idea is likely to remain for ever buried, for the same reason which originally called it forth will again in the march of improvement demand its resurrection. And the particular idea which now bids fair to be of vital consequence and utility in the further development of continuous-current apparatus is that illustrated by the use of what are commonly known as commutating or inter-poles, but which in a broader sense may be termed the method of neutralizing armature reaction and eliminating sparking by automatically varying the polar resultant, or correcting the distortion due to varying relations between armature and field strengths in dynamo-electric machinery.

In this specific form the commercial application of the inter-pole has been comparatively recent, but since this general method is one which is fundamental to the larger development of non-sparking continuous-current machines operated at increased potentials, I derive more than ordinary satisfaction from the fact that both the idea and practice originated with me a good many years ago.

In the stationary motors which I for some time constructed with double coils, the series winding was a distorted one, and intended to shift the field in one direction only, but on motors installed and operated for some months in the year 1886 on the Thirty-fourth Street branch of the elevated railroad the series armature coil was equally distributed so as to tend to produce the supplemental poles equally midway between the normal ones. No actual polar projections at these points were used, but this is a physical not a fundamental difference; and, as stated, consequent not salient poles were



Diagrammatic Sketch of Early Motor.

used in these early constructions. The actual construction of the fields and the winding of the series field coil, as well as its connection to the armature and reverser, are illustrated in the accompanying sketch.

The shunt winding, making the poles *N* and *S*, is omitted for clearness. The variable supplemental poles are *n* and *s*. The late Prof. Henry Rowland, in reporting upon the features distinguishing the early practice of the old Sprague Electric Railway and Motor Company, pronounced this a most important and valuable advance. This general idea, since quite independently, I assume, conceived and applied to salient pole machines, bids fair to revolutionize much of the continuous-current practice, and is one of the principal features which, I unhesitatingly assert, is going to make possible very much higher potentials in direct-current machines. Those who have experimented with this development have been astonished with the results, and the freedom of design which it leaves in the hands of the constructor. Not only American, but English and German manufacturers are rapidly becoming interested in it, and some of the possibilities are indicated in an interesting paper by Dettmar in a late article in the *Elek. Zeit.*, from which I quote the following brief extract:

"On account of the necessity for obtaining good commutation, direct-current dynamos have been built in the past mainly for electromotive forces not over 700 volts, for large generating sets not over 1100 volts, and in extraordinary cases 2000 volts have been employed. With the use of interpoles it will be easy to at least double the voltage. This should have an important effect on direct-current traction and simple power transmissions. . . . It may, therefore, be assumed that there will be a tendency in the future to make interpole construction the rule."

Of course this is but one element of the problem so far as railroad practice is concerned, and there are other important essentials. But the possible increase of potentials directly used on individual motors to 1500 volts, to say nothing of what may be used in combinations of motors, promises important developments in direct-current work. And when to this is added the fact that by special methods of regulation not only can there be a range of at least six or eight to one in economic speed under load, with the utmost refinement of variation, but that in addition, where there are down grades, the locomotives can be used to restore energy to the line through a complete range of like character, if the gain warrants the increased size and cost of apparatus common to all proposals for return of energy, some idea may be had of possible future developments.—Abstracted from *Electrical World*.

Single-phase Induction Motor Theory.

THE development of single-phase motors, especially those used for railway work, owes much to theoretical deductions regarding their possible performance, and on these mathematical conclusions affecting the practical design have been based leading ultimately to the commercial machine. Our contemporary, the *Electrical Review*, recently published a long series of articles from the pen of Mr. Val. A. Fynn on the theory of single-phase induction motors, which is of considerable interest and withal a valuable contribution to the literature of the subject.

In dealing with the series we cannot do better than present our readers with the concluding article which gives a summary of the argument put forward :—

In conclusion the author thinks that the main features of his theory of the single-phase shunt induction motor could be more easily impressed on the memory by representing diagrammatically, for a given direction of rotation and for some particular instant, the directions of the various fields, e.m.f.'s and currents involved, much in the same way as is usual in the case of continuous-current machines. It is hoped that the Figs. 14 to 22 will achieve this object. The first three figures represent the well-known conditions obtaining in continuous-current generators and motors. Gramme-ring windings, all wound in the same direction, are supposed to be made use of in the Figs. 14 to 22; for the sake of clearness they are only indicated in the first three.

Fig. 14 shows a continuous-current generator having a field F of the direction indicated by the arrow. Assuming a direction of rotation R, the direction of the working e.m.f. (E T) generated in the armature winding will be given by the arrows shown in that winding. In the case of continuous-current machines the current will

C.C. Generator

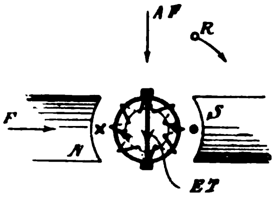


Fig 14

C.C Generator.

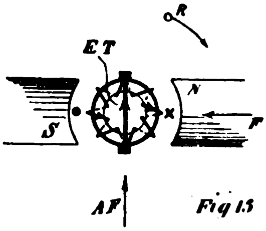


Fig 15

C.C. Motor

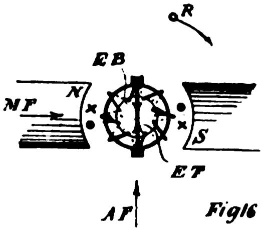


Fig 16

Single-Phase Shunt Induction Motor.

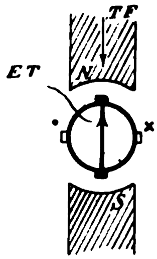


Fig 17

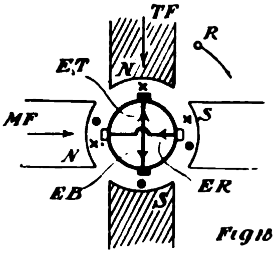


Fig 18

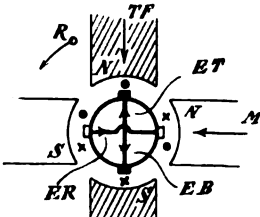


Fig 19

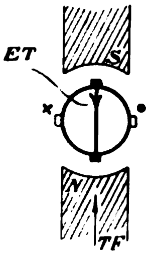


Fig 20

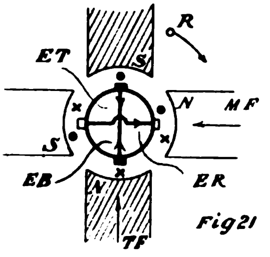


Fig 21

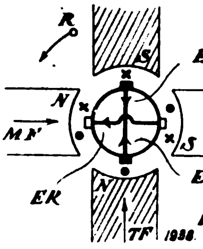


Fig 22

always be in phase with its e.m.f., and these arrows will, therefore, also show the direction in which the current will flow through the armature winding. The conditions will not be altered in any way if the brushes be short-circuited, and the current will flow from the top to the bottom brush, this armature current setting up a cross field in the direction A F and causing a distortion of the main field indicated by the shading on the poles N and S. This particular distribution of current along the armature conductors is also indicated by the cross and dot placed in the air-gap. Fig. 15 shows the conditions prevailing for a reversed direction of the generator field, and Fig. 16 illustrates the state of things in a motor. Here again the brushes are shown short-circuited; the working e.m.f. (E T) is supposed to be introduced by means not indicated. The brushes have in all cases been shown short-circuited, so as to allow of a more direct comparison with the shunt induction motor; it need hardly be said that this does not correspond to continuous-current practice. Now the direction of this working e.m.f. (E T) is such as to send the current in at the top brush and out at the bottom brush; the distribution of the current along the armature conductors is shown by the dot and cross placed in the air-gap below the horizontal centre line. The direction of the motor field being given by M F, the motor will revolve in the direction R setting up a back e.m.f. (E B) opposed to the working e.m.f. (E T), the armature current will flow against this back e.m.f., the distribution of which is shown by the cross and dot in the air-gap *above* the horizontal centre line. This back e.m.f. is the e.m.f. generated in the rotor winding by its revolution in the field M F, and its direction can be ascertained from Fig. 14. The cross field is indicated by A F and the distortion it causes by the shading of the poles N and S. The meaning of the dots and crosses in the air-gap being thus absolutely defined, the armature winding itself can be omitted in the following figures without fear of confusion.

In examining the conditions prevailing in an alternating-current motor, and in applying to it the rules laid down in Figs. 14, 15 and 16, we have in addition to take phase differences into account. Now the question arises as to how a phase difference is to be correctly expressed by means of a direction only in such diagrams as Figs. 14 to 16. Taking, for instance, the well-known case of the e.m.f. of self-induction, we know that the latter lags by 90° behind the current to which it is due, and we also know that such an e.m.f. always *opposes* any change of that current. It will therefore be correct to represent this lagging e.m.f. as opposed to its current, and generally it will consequently be correct to represent a lag by an opposite and a lead by the same direction.

Taking Fig. 17, and assuming the transformer field T F to have at the instant chosen the direction indicated by the arrow, and it being known that the undulations of this field will set up an e.m.f. in the rotor lagging by 90° behind this field, it is clear that this e.m.f., which is our working e.m.f. (E T), must be represented as opposed to the field T F; its distribution along the armature is shown by the dot and cross in the air-gap *above* the horizontal centre line. We will assume the working current to be in phase with E T (in practice this is nearly true, as has been shown); this current will therefore flow in the same direction as E T—that is, from the bottom brush to the top brush. If we now give this motor an initial impetus in the direction R (Fig. 18), and short-circuit the field brushes (white brushes), the rotation of the armature conductors in the field T F will generate the e.m.f. (E R) along the motor field axis. This e.m.f. will be co-phasal with T F; its direction can therefore be ascertained directly from Fig. 14. This e.m.f. will produce a magnetising current and a field both lagging behind it by 90°, and therefore opposed to it in direction, as shown by arrow M F. The torque is produced by the current flowing by way of the armature brushes (black brushes) in the direction E T, and by the motor field M F. A reference to Fig. 16 will show that the conditions brought about by the initial impetus given to the motor are really such that the machine *must* continue to run in the same direction; but the rotation of the rotor conductors in the field M F will also generate an e.m.f. in phase with this field, and along the axis of the armature brushes; this is E B, the back e.m.f., and a reference to Fig. 14 will at once help to determine its direction. The latter is given by cross and dot in the air-gap and *below* the horizontal centre line; it is seen that E B in Fig. 18 must be opposed to E T, which again agrees with the conditions prevailing in the continuous-current motor (Fig. 16).

If the motor is given an initial impetus in the opposite direction, as shown in Fig. 19, the same line of thought will show that it must also continue to run in that opposite direction, and will bear out all the other main features of the theory which has been put forward. In Fig. 20 an instant has been chosen when the transformer field is of a direction opposed to that assumed in Fig. 17, and it will be seen by following out the various effects in the way already indicated for Figs. 17 and 18, that this alteration in the direction of the transformer field is without effect on the direction of rotation or on the general operation of the motor.

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High-speed Electrical Machinery.

PROF. S. P. THOMPSON recently completed a series of interesting discourses on the above subject, forming Howard lectures before the Society of Arts. British electrical engineers have always been enamoured of quick-revolution type of steam engine, and through their untiring efforts and patience high-speed reciprocating engines and ultimately turbines have become commercially practicable. For this reason the design of any dynamo electric machine to operate above 500 r.p.m. is a matter of extreme interest, while we do not need to enlarge on its commercial importance. Space will not permit us to go over Professor Thompson's lectures in detail, but the following close abstract, which is taken from our contemporary *Power*, will be found to give a concise epitome of the subject:—
Mention was made that in 1862 Holmes had supplied a direct-driven dynamo running at 110 revs. a minute. At that time, however, slow speeds were accepted practically for all stationary engines. Dynamos, on the other hand, ran at high speeds, the drive being by

belt. In 1892 Mr. J. E. H. Gordon put down at Paddington four two-phase direct-driven alternators with revolving fields and stationary armatures. The well-known Jumbo dynamo was also direct-driven by Allen-Porter engine running at 350 revs., and a Ganz unit was also exhibited at Vienna. These cases of foreign practice were, however, exceptional. For direct-connected units the tendency was to reduce the speed of the dynamo in Germany, and also in Switzerland, where water turbines were used. Here, on the other hand, owing largely to Willans and Robinson and Belliss and Morcom, the speed of the engine was increased.

In the design of generators the permissible current depends on (1) heating in the armature, (2) the armature reaction, and (3) the avoidance of sparking. In the same way voltage is limited by (1) speed of the armature, (2) strength of the magnetic field, and (3) insulation resistance. Further, the power is determined by (1) the ability of the mechanical construction to take the turning effort, (2) the efficiency of conversion, and (3) the overload capacity.

An experienced designer could start anywhere in the lay-out of a new electric generator. One plan was to consider each pole as giving a definite output. This was criticised on the ground that the output per pole may range from 8kw. in small machines to 70kw. in large direct-current machines. The range in alternators was almost as great. The method proposed by Mr. Sidney Short was that of standardising the poles, using a constant surface speed of 3300ft. a minute, while the speed of revolution in all sizes would vary inversely as the output. But steam engines did not conform to this law, the output varying inversely as the (speed) $\frac{3}{2}$. Another method was that of Mavor, who calculated on the active belt of the armature.

Turning to commutation, while in an alternator the current rose and fell in gentle waves of the sine curve order, in the direct-current machine the waves were flat topped, so that the commutators had to change the direction from a maximum one way to an equal maximum the other way in less than ·005sec., or in very high-speed machines ·001sec. As to reactance, a strip 1in. by $\frac{1}{16}$in. had the same cross section as a square rod of $\frac{1}{4}$in. side, yet the periphery being only one-half the magnetic effect round the square bar will be double that round the rectangular strip. The diminished reactance was a point in favour of strip winding. Carbon brushes owe their value to high resistance and the formation of a high-resistance film on the commutator surface. A highly-polished commutator offered higher resistance than an unpolished commutator. The resistance of copper gauze brushes increased with the speed, but appeared to be at a maximum at about 800ft. a minute. Film resistance was the secret of natural commutation, but resulted in a drop of from 1·6 to 2 volts, in addition to the normal armature drop. In turbo-generators, Parsons uses brass brushes, the positive brush sometimes working in a different line on the commutator from the negative brush. The De Laval turbine of a lower speed used carbon brushes; the Brown-Boveri dynamo had compensating windings; while the Oerlikon Company used separate commutating poles. The Brush Company used small commutating poles, but with a compensating winding in addition. Attention was drawn to the carbon brush of the Morgan Crucible Company, Battersea, London, S.W. Eddy currents were prevented by the brush being stratified lengthwise. Then, while the back part was of a highly conducting carbon, the front was of a harder, more resisting material.

Turning to alternators, in turbo machines there were always a small number of poles with a wide pole pitch. The stress due to centrifugal force was of importance. The pull on every pound of conductor at the surface of a small rotor would not be less than 1000lb., and in some machines might amount to three or four tons. Air-gaps were now greater. Thus a considerable stray field was set up which rotated and induced eddy currents in the windings and shields. Another effect of increased pole pitch was that the additional curvature of the pole increased the length of path of a number of magnetic lines. These tended to crowd against the back of the slots, and the yoke had to be increased in section. Then the winding had to be of stout copper strip, which implied a large exciting current with low voltage, one result of which was that insulation troubles were reduced. Earlier alternators had rotating armatures, but now the rotating field was general. The poles were usually solid. Generally constructors paid great attention to cooling. Some allowed the heated air to escape as was convenient through the casing, while others caused it to pass along a definite path.

The Cost of Insulation.

CLOSELY associated with the design and manufacture of dynamo electrical machinery is the cost of the necessary insulation, and a detailed consideration of the subject is to be welcomed. In a recent issue of the *Electrical Engineer*, Mr. H. M. Hobart graphically detailed his deductions on the matter and presented valuable results which should be procured for reference.

Mr. Hobart divides the subject into several parts, showing first the cost of insulating the commutator, next the cost of insulating the armature of direct and alternating current machines. Finally, the cost of the field insulation is taken up for direct and for alternating current machines. Curves are given showing the variation in the cost of each of these factors for machines of different types, and also for the total cost of constructing each part of the machine. Machines varying in output from 200 or 300 to 4000 kilowatts and in voltage from 500 to 12,000 are discussed. In order to avoid unduly complicating the subject certain assumptions are made, but it is believed that these do not affect the result essentially. For example, the cost of commutator insulation varies from thirty-five per cent. of the total insulating cost in small machines up to fifty per cent. in large machines. These costs are for the insulation in form ready for use. No attempt is made to consider the cost of manufacturing the finished insulation from the raw materials. Also, the labour for insulating the field spools is so closely associated with that of winding them that they cannot be separated, so that the total cost for this is charged against insulation. It is found that the cost of commutator insulation is generally between seventy-five cents and $1 per square decimetre of peripheral surface of the commutator. This value tends to be higher in 500-volt machines and lower in 100-volt. It also decreases slightly with increasing size of commutator. The cost of commutator insulation is generally between two and four per cent. of the total shop cost of the machine. Although the price of labour varies considerably in different countries, it has been found that the most expensive labour generally gives the cheapest work, but the difference is so small that the figures for one country can be used with close approximation to obtain results in other countries. These data are given in various forms, one set of diagrams showing the cost of material, labour and other manufacturing charges in percentage of the total cost of the machine. Another set shows the cost of insulating the armature in terms of the weight of armature copper; another a similar set of curves for estimating the insulating costs of both armatures and fields in terms of the weight of the copper. Examples are given, showing how these curves may be used to determine the best design of a machine for any particular case. For example, it is found that if the insulating cost of the machine is not to be more than five per cent. of the total shop cost, a machine for 3000 volts cannot be constructed for over 200 kilowatts, while a machine for 12,000 volts could be as large as 2000 kilowatts.

Notes on Design.

The repulsion motor may have its field winding grouped for about 6600 volts, which is the practical limit of safe voltage on a traction motor. A given motor must have its field adapted to one voltage. Concerning the relative power-factor of these motors it will be found in general that engineers compare this characteristic at synchronous speed, whereas consideration should be given to the relation between full load, synchronous and free-running speeds, as this relation is the basis on which to draw logical conclusions.—T. H. Schoepf, Manch. I.E.E.

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Referring editorially to Mr. C. W. Hill's paper on crane motors before the I.E.E., the *Electrician* says: "The very favourite system of specifying that the motor is to give a certain horse-power for an hour with a certain temperature rise, although convenient as being easily checked by tests, is not equally fair to motors of different sizes. And on the other hand the simple statement that the motor is to give a certain horse-power at a certain load-factor is incomplete if some mention of the length of the run is not made. A fuller specification of some sort is necessary, and it is only by wide experience of actual working that the most suitable compromise can be arrived at."

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The Mechanical Equivalent of Light.

By EDWARD L. NICHOLS.

PRODUCERS of artificial light have been content for a long time to measure their product in units the relation of which to the units of energy expended in its manufacture was unknown. That there is such a thing as the mechanical equivalent of light has, however, been recognised almost from the time when it had been established that radiation is a form of energy and light a special type of radiation. That the determination of the mechanical equivalent of light is not of purely academic or even of purely scientific interest has likewise been recognised, and attempts have been made from time to time to determine it.

The first of these attempts was that of Thomsen,[*] who in 1865 measured the total energy radiated by a standard candle by comparing the effect upon a thermopile placed at a known distance from the flame with that upon the same instrument when exposed to the radiation from a hollow ball containing hot water. The energy lost in a unit of time by the ball was ascertained from its rate of cooling. To determine what proportion of the radiation from the candle flame was light-giving, Thomsen compared the radiation received by the thermopile, when exposed directly to the flame with that transmitted by a glass cell containing a layer of water 20cm. in thickness.

Twenty-three years later, in 1888-89, Tumlirz[†] took up the problem. In the meantime the first important step necessary to the success of such an investigation had been made in the substitution for the candle of a definite and reproducible standard of light; and Tumlirz adopted as the subject of his experiments this standard: the flame of the Hefner lamp. As the result of his measurements, which were carried out with extraordinary care and precision, account being taken of all thinkable sources of error, Tumlirz found the light-giving energy received upon one square centimetre of surface at one metre distance from the Hefner flame to be 36.1×10^{-8} gram calories per second. This value is considerably smaller than that obtained by Thomsen, whose result, recomputed and reduced to the same terms, was 56×10^{-8} gram calories per second from the candle flame.

Tumlirz in his paper considered the question of determining the ratio of the light-giving to the total radiation by dispersion of the rays; but he unfortunately rejected this more rigorous method on account of the experimental difficulties which

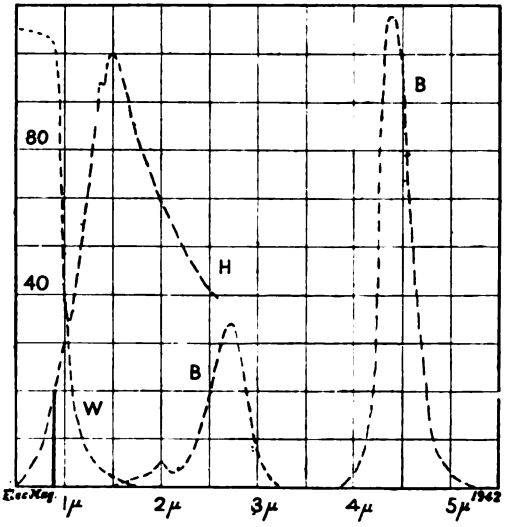

FIG. 1.

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[*] Thomsen: Poggendorff's Annalen, 125, p. 348.

[†] Tumlirz: Wien. Berichte, 9711, pp. 1521 and 1625; also Wied. Ann. 38, p. 640.

it presents, and contented himself, like Thomsen, with the use of a thick water-cell. He convinced himself of the opacity of this cell to non-luminous radiation by experiments with the Bunsen flame, no portion of the radiation of which was transmitted to the thermopile. This check upon the method is inadequate for the reason that the infra-red spectrum of the Bunsen flame[*] consists merely of two emission bands, at wave lengths 4.25μ and 2.70μ; in which regions both glass and water are quite opaque. The infra-red spectrum of a luminous flame such as that from the Hefner lamp, on the other hand, contains a considerable amount of energy of shorter wave lengths which is capable of transmission through both glass and water. The curve B in Fig. 1 indicates the distribution of energy in the infra-red spectrum of the Bunsen flame. The curve W in the same diagram indicates the percentage of radiation as a function of the wave length transmitted by a water cell. A portion of energy curve for the Hefner flame H is also given.

The error introduced by the assumption of the complete opacity of the water cell for infra-red radiation is very large. The ratio to be measured may be shown graphically by plotting the curve of the distribution of energy in the spectrum of the source of light and dividing the area enclosed by that curve into two parts by means of a vertical line at wave length 76μ, which represents the limit of visibility at the red end of the spectrum (see Fig. 2). The ratio of the total area OBCD to the area OBR, which comprises the whole of the light-producing radiation and excludes the infra-red, is the quantity to be measured. The energy transmitted by the water cell was assumed to coincide with this area; but such a cell, as we now know from subsequent explorations,[†] actually transmits radiation, the spectrum of which is represented by the curve OB′C′D′. In addition to the light-giving area OB′R, somewhat reduced by losses due to reflection and absorption, the cell transmits infra-red radiation corresponding to the area RB′C′D′, and this exceeds in amount the light-giving radiation. The true value of the ratio of the luminous to the total light-giving radiation from the Hefner flame, as determined by a method free from this source of error, to be considered presently, is about .009. The measurements of Tumlirz, however, gave for this value .024. The first corresponds to the ratio $\frac{OBR}{OBCD}$, the second to $\frac{O'B'C'D'}{OBCD}$.

Further evidence that the measurements of Tumlirz give too large a value for the mechanical equivalent of light may be obtained by computing from his data the energy of total light flux from a source of unit intensity. This quantity, found by multiplying the energy received on a square centimetre at metres distance by $4\pi \times 10^4$, is .4054 gram calories per second or .188 watts for a source one hefner in intensity. A glow lamp at three watts per hefner would therefore have a radiant efficiency of $\frac{.188}{3} = .055$. This value agrees well with the accepted determinations by the older methods for the radiant efficiency, in which the water cell was used as a means of separating the light-giving from the non-luminous radiation. The most recent determination, made by C. E. Mendenhall[*] by a method free from this error gives, however, .026 for an incandescent lamp filament at normal brightness.

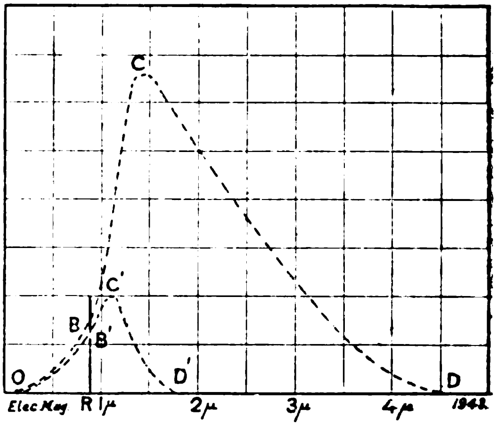

FIG. 2.

In 1903, Knut Angström[†] made a redetermination of the mechanical equivalent of light and as his investigation affords us for the first time values of this important quantity which are free from large errors I shall describe the method employed in some detail.

(To be continued.)

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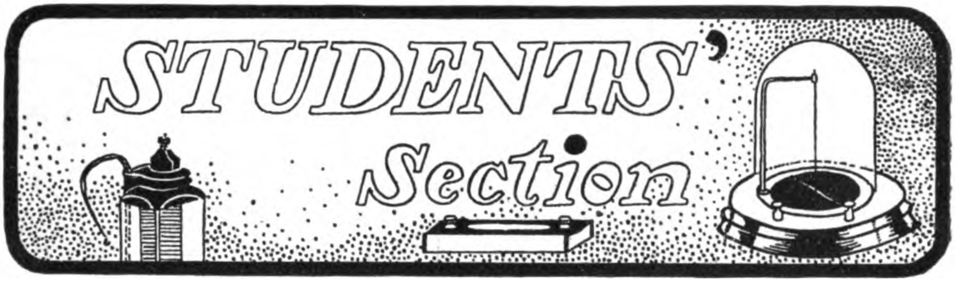
[*] Nichols : Standards of Light ; Proc. of the International Electrical Congress at St. Louis, 1904.

[†] See Nichols and Coblentz, *Physical Review*, Vol. XVII., p. 267.

[*] Mendenhall, C. E. : *Physical Review*, Vol. 20, page 160.

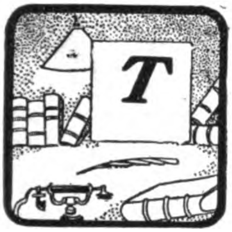
[†] Angstrom : Royal Society of Sciences, Upsala, 3rd Series. Vol. XX., 1904.



Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Balancers.

By B. FRANKENFIELD.



THIS comparison is limited to symmetrical three-wire systems of distribution or systems in which the voltages between either main and the neutral are approximately equal. Its interest lies in the remarkable parallelism inherent in the two classes of apparatus when operating on a simple resistance load, such as incandescent lamps.

At the outset let it be stated that the direct-current balancer is a piece of apparatus the virtues of which are becoming more and more appreciated with every year of service. Its chief advantage lies in its adaptability to systems using standard generators of any make, thus avoiding the employment of three-wire generators of highly specialised design. On lighting circuits it operates without a thought on the part of the attendant, faithfully compensating for the somewhat fickle shifting of the load from side to side, and with a promptness and accuracy beyond human attainment in the hand-regulated systems. On multiple voltage power circuits no load is too erratic, no change too violent, for it to follow with perfect ease. The balancer is to the network a faithful sentinel guarding against every attack upon the integrity of the regulation.

The autotransformer possesses many of the same good qualities, but cannot attain the same efficacy in the matter of regulation. In addition, its duties are more severe in that it may be called upon to supply reactive currents, a factor with which a direct-current system does not have to contend. The autotransformer is little used in lighting circuits due to the employment of high primary voltages and three-wire transformers. It is, however, applicable to low-tension systems of generation and has been used to a limited extent.

Fig. 1 represents a direct-current, three-wire system, employing a balancer consisting of two like dynamo-electric machines M and G, mounted on a common base and mechanically coupled to rotate at the same speed. The two armatures are connected in series across the mains and, at their common point of connection, to the neutral of the system. The field windings are connected in series across the mains.

All current common to the two sides of the distributing system is furnished directly by the generating station, and the balancer is called upon only for the difference in current between the two sides—the neutral current. Balanced load then is zero load on the balancer and in dealing with the present problem all load is considered as confined to one side of the system, this load

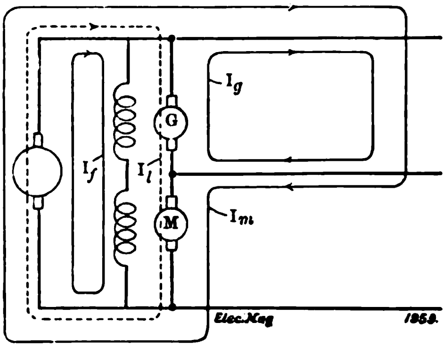


FIG. 1.

being understood as the excess of load on one side over that on the other.

At no load, balanced load on the system, the two machines act as motors running light. There is a magnetizing current I_f in the field windings and a loss current I_l in the armatures of sufficient magnitude to supply the equal stray power losses of the two machines. As the load becomes unbalanced, say in favour of the upper side of the system, the terminal pressure of the machine G approaches more nearly to the counter pressure and the loss current I_l becomes unequally divided, decreasing in G and increasing in M by an equal amount. The excess of this loss current in M is supplied by the establishment of a current I_n in the neutral. A further unbalancing still further decreases the loss current in G and increases the loss current in M until a point is reached where the loss current in G is zero and the machine M carries the entire loss current of the two machines. At this point G is acting as a generator operating at zero load, M as a motor under a load equal to the stray power of G, and the current I_n is equal to 2 I_l of the no-load condition. A further unbalancing establishes a current I_g, a generator current emanating from G, and increases the current I_n enough to supply I_g and its attendant losses. The field current I_f, of course, remains fixed for all loads with a fixed supply pressure.

Fig. 2 represents the above sequence graphically. Motor currents and generator currents are plotted respectively to the left and to the right of the zero. The vertical scale represents watts output of motor and watts intake of generator, and the horizontal distance between the two curves is the neutral current. At balanced load the distance O *a* represents the current I_l, a motor current equal in each machine. As the load becomes unbalanced the motor current of one machine decreases, and that of the other increases an equal amount. Finally, at a transmitted wattage between the two machines, equal to O *b*, the armature current of one machine is zero, and that of the other 2 I_l, equal to I_n, which is also the neutral current. A greater unbalancing introduces the generator current, as shown. Below the point *b* the neutral current represents the difference between two motor currents; above *b* it is the sum of the motor current I_n and the generator current I_g.

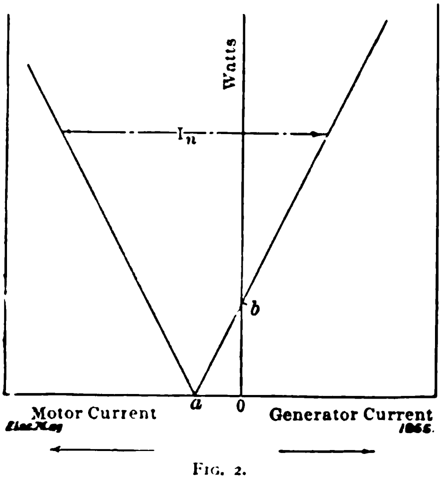


FIG. 2.

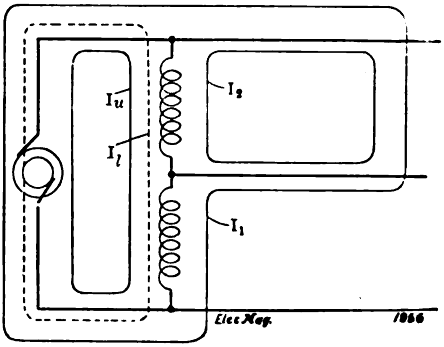


FIG. 3.

Fig. 3 represents an autotransformer operating under like conditions. It is assumed that the windings are of uniform cross section throughout, and that they are divided into coils intermeshed after the manner of the secondaries of three-wire transformers, so as to render leakage a negligible quantity, at least for the purpose in hand.

At balanced load there is a magnetizing current I_μ common to the two circuits of the windings, and in quadrature with it a core-loss current I_h, also common to both windings. These two currents combine vectorially to form the no-load or leakage current of the transformer. The magnetizing component corresponds to the field current in the direct-current analogue, and remains constant regardless of the load. When the load is overbalanced on the upper side of the system the core-loss current in that side decreases, and the core-loss current in the lower side increases an equal amount. This establishes a primary current I_1 in that part of the winding connected to the lower side of the system. I_1 corresponds to the direct-current I_m. As the unbalancing increases the core-loss current becomes less in the upper winding and greater in the lower, until finally it becomes zero in the first and of a value $I_1 = 2\,I_l$ in the second. At this point the upper winding is acting as a generator or secondary winding without load and the lower as a motor or primary winding, supplying all of the core loss. A further unbalancing* establishes a secondary current I_2, corresponding to I_g, and the primary current is increased by an amount equal to I_2 plus the losses incident to its maintenance.

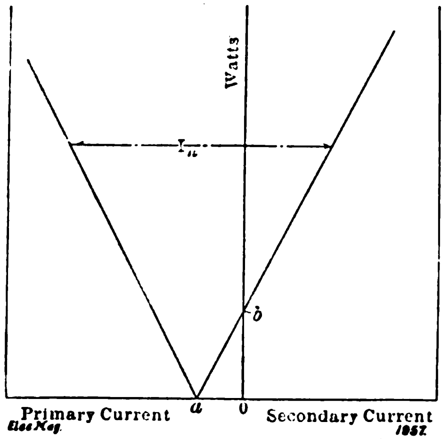


Fig. 4.

Referring now to Fig. 4, which is self-explanatory, O *a* (= I_l) represents the loss current in the two coils at balanced load. It is a primary current, each coil acting as the primary of a transformer on no load. As the unbalancing increases the core-loss current in one coil approaches zero as a limit and that in the other coil 2 I_l as a limit. The limit is satisfied at the point *b* where one coil is acting as secondary about to furnish current, and the other as primary assuming the entire burden of the losses. O *b* may be called the output of the primary at this point. It is equal in value to half the total core loss—*i.e.*, it is the loss once assumed by the now secondary coil, but at present thrown upon its mate. A further unbalancing establishes a secondary current as indicated. Below the point *b* the neutral current is the difference between two primary currents, and above *b* it is the sum of the primary current I_1 and the secondary current I_2.

The analogy on non-inductive load is thus complete. The critical point *b* would be indicated by an ammeter in the armature circuit of the generator (Fig. 1), reading zero, and by an ammeter in the corresponding circuit of the secondary (Fig. 3), reading a minimum value. In the latter case the reading would not become zero, because of the existence of the magnetising current I_μ. Perhaps a better illustration would be shown by a wattmeter connected to measure secondary output. If connected to read positive for points above *b* it would read zero at *b*, and would reverse for a point below *b*. Reversing the pressure coil it would again read positive for loads approaching a balance, the indication increasing until, at balanced load, the reading would equal half the total core loss of the apparatus. The wattmeter experiment is somewhat difficult to perform, because of the small quantities involved, and an old-time high core-loss transformer is more suitable for the purpose than a modern one.

The comparison of the two classes of apparatus must cease with non-inductive loads or it will lose its instructive value. The autotransformer, and likewise the transformer, are interesting studies when applied to three-wire systems with loads of unequal power factor. For instance, it is possible to have equal currents in the mains and a neutral current, not only greater than zero, but in excess of the main current. These problems will not be pursued to a conclusion in the present article; they are merely cited to show that it is not wise to cling religiously to analogies, and to emphasize again that the present comparison is confined to non-inductive loads.—*Electrical Review*, N.Y.

◆

Self-restoring Detectors for Wireless Telegraphy.

By W. H. MARCHANT.

The ordinary filings tube coherer after being acted upon by Hertzian waves remains in its conductive condition and is not available for the detection of fresh signals until restored to its former state. This is usually done by an arrangement known as a tapper, which is constructed on

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* The primary and secondary load currents are opposed magnetically but in phase in the neutral wire, as may be seen by assuming instantaneous values of electrical pressure, preferably of the same polarity as shown for the direct-current analogue.

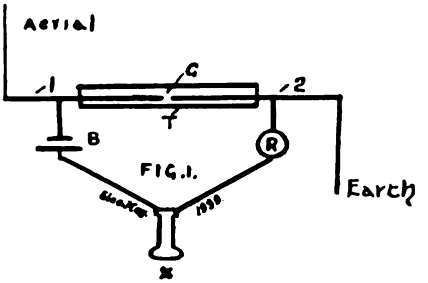


FIG. 1.

the same principle as a trembler bell. By tapping on the tube it shakes the filings and so restores the coherer to its former receptive condition.

This tapper has proved to be a troublesome piece of apparatus and several systems have been invented in which the detector is self-restoring, the tapper therefore being rendered unnecessary. The De Forest electrolytic detector is one of the best known of these. It consists of a small glass tube T (Fig. 1) into which are inserted two brass electrodes, 1 and 2. A small quantity of paste made of metal filings, oxide of lead, glycerine, and water is inserted in the gap Y, which is adjustable. The action ascribed to it is as follows: The current from the battery B causes minute particles to be detached from the anode and carried over toward the cathode, thus forming a sort of conducting bridge. The effect of the waves is to cause small hydrogen bubbles to form, thus increasing the resistance and therefore reducing the current through the telephone, which gives out a buzzing sound.

Fig. 1 shows the arrangement of circuit. B is a battery, R a resistance, and X a telephone receiver. Another very sensitive detector is that known as the Italian Navy Coherer. This consists of a small globule of mercury about 1½ millimetres in diameter placed between two electrodes— one of carbon, the other of iron. A telephone is used as a reading instrument and the circuit is arranged as Fig. 1. In Fig. 2 is depicted one form of the Marconi magnetic detector. On the pulleys P and P an endless band formed of several iron wires is caused to circulate; during its journey it passes through the glass tube T, on which is wound the primary coil P, the ends of which are connected to aerial and earth. Over the primary a secondary coil S, having a great number of turns, is wound, the ends being connected to a telephone receiver. Two powerful horseshoe magnets are placed in a position shown in the diagram, their like poles being together. The apparatus depends for its action on the fact that electrical oscillations have the power of annulling the hysteresis of iron. The arrival of waves causes a redistribution of the lines of force through the secondary, and thus causes the telephone to give out a sound. With this instrument, as with the others mentioned, it is possible to signal at a much higher rate than that attained when a filings coherer is used.

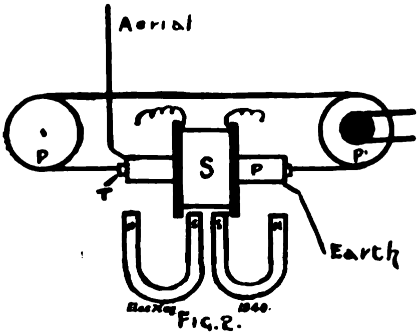


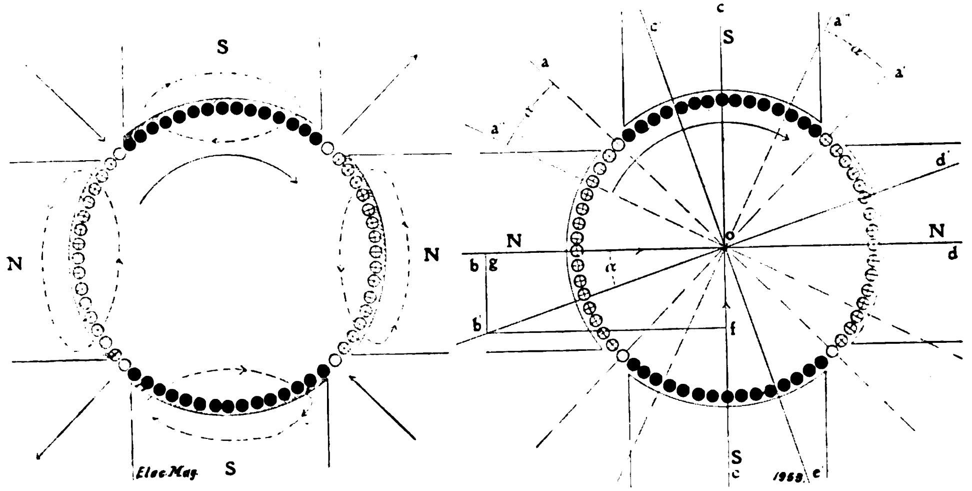
FIG. 2.

Auxiliary Pole Motors.

STUDENTS cannot fail to be interested in the recent revival of interpoles for direct-current motors, as these machines are likely to take an important place in the electrical field before very long. The following was contributed to the *Electrical World* recently by N. G. Meade and will be found instructive :

"In Fig. 1, *N*, *S*, *N*, *S* are the four poles of an ordinary multipolar motor. The light and dark circles about the periphery of the armature represent the conductors. In the dark circles the current is supposed to be flowing away from the observer, and in the light circles toward the observer. Under these conditions, with the armature revolving in the direction of the curved arrow the magnetic flux set up by the armature conductors travels in the paths shown by the dotted lines, producing the well-known phenomenon of weakening the leading pole tips and shifting the neutral point.

"In Fig. 2 this is shown in a somewhat different manner. The dotted lines, *a* and *a'* represent neutral lines without armature current. From *b* and *d* to the origin, *O*, thence to *c* and *e*, illustrates graphically the path of the field flux. To show the effect of armature reaction, let *f-o* represent the flux set up by the cross-ampere turns of the

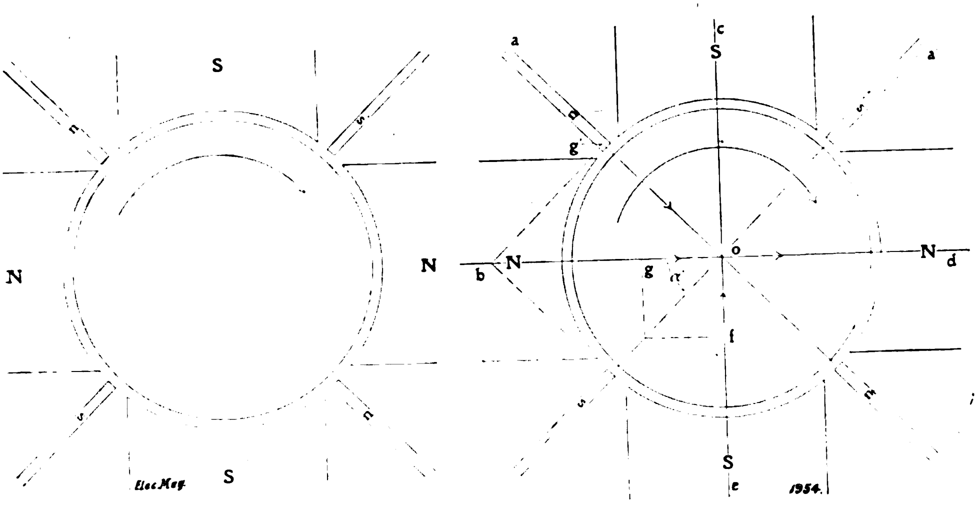


FIGS. 1 AND 2. DIAGRAMS OF CIRCULATION OF ARMATURE CURRENTS.

armature, which acts at an angle with the field flux represented by *g-o*. Now, considering these two factors as forces, they resolve themselves into a parallelogram, and the diagonal, *b′-d′*, and the line at right angles, *c′-e′*, give the new path of the field flux, it having been shifted through the angle, *a*, by the effects of the armature reaction, causing the no-load neutral lines, *a* and *a′*, to shift through an equal angle to the positions *a″* and *a‴*.

"As the factor *g-o* varies with the change of speed by field weakening and the factor *f-o*, with the load, the position of the neutral point is dependent on the magnitude of both factors and the position for sparkless commutation varies accordingly.

"The addition of auxiliary poles as shown in Fig. 3 introduces a new element, the effect of which is graphically illustrated in Fig. 4 in an exaggerated manner. In the example given it is assumed that the motor is operating at one of its higher speeds; consequently the field is considerably weakened by the introduction of resistance which reduces the factor *g-o*, shifting *b-d* and *c-e* to positions parallel with the theoretically neutral lines, *a* and *a′*. Let *g′-O* represent the auxiliary pole factor acting on the first diagonal at *O*; then the diagonal of the second parallelogram will be *b-d*, restoring the neutral points to their normal position."



FIGS. 3 AND 4. DIAGRAMS SHOWING EFFECT OF AUXILIARY POLES.

From Professor to Student.

Why is the positive pole of the main battery of a common battery telephone system put to earth, and not the negative pole? If the negative were put to earth, what effect would this have on the working of the system?

The earthing of the positive pole has nothing special to recommend it; the arrangement, having been adopted in the earliest common battery systems, has now become standard practice. But equally good results would be obtained by earthing the negative pole, and the working of the system would not in any way be affected. There are in this case no special considerations rendering it advisable to earth one pole rather than the other, such as those which have made the earthing of the *negative* pole standard practice in traction work.

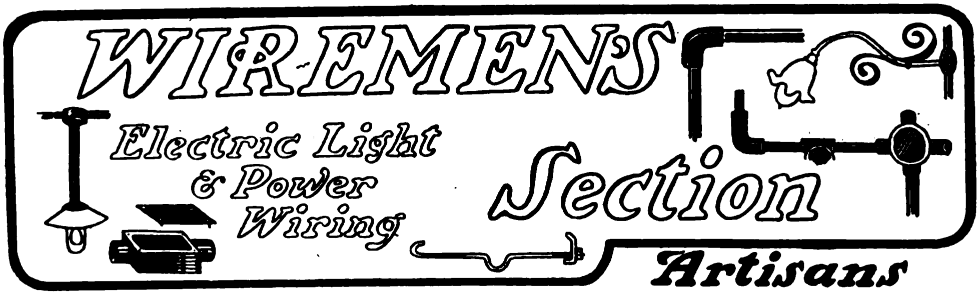
Is it possible to ascertain with any degree of accuracy the p.d. across the winding of a solenoid with an iron core, the resistance of the coil, dimensions of bobbin and core, and alternating current passing through the solenoid being known?

If the solenoid is sufficiently long in comparison with its cross-section the relation connecting the p.d. and current may be approximately determined by assuming the magnetic flux through each turn to have the same value. The magnetization curve, or curve connecting B (magnetic induction) and H (magnetic force) must, of course, be known, as must also the frequency. Let the r.m.s. (root-mean-square) value of the current be I′, then its maximum value is $I = \sqrt{2} . I'$. The maximum value, H, of the magnetic force is given by $H = 1.257\, SI$, where S stands for the number of turns per cm. length of solenoid. Having found H we refer to the B—H curve and find the corresponding maximum value B of the induction in the core. If a be the cross-sectional area in sq. cms. of the core, Ba gives us the maximum magnetic flux per turn. The maximum value of the e.m.f. induced in each turn is pBa, where $p = 2\pi \times$ frequency. The maximum value of the total induced e.m.f. is thus $SpBa$. The maximum value of the drop due to the resistance of the coil is rI where $r =$ resistance of coil. Draw two lines at right angles to each other; along one lay off, to a convenient scale, a length to represent $SpBa$, and along the other a length to represent rI. Complete the rectangle of which the two lines are sides, and measure the length of the diagonal. This latter length, divided by $\sqrt{2}$, gives us the required r.m.s. value of the p.d.

The above method is only approximate in that it entirely neglects the hysteresis and eddy-current losses in the core, and in that it assumes the magnetic flux to have the same value through each turn of the coil. The flux, as we know, gradually leaks out through the sides of the coil as we proceed from its middle towards the ends, so that there is a steady decrease in the flux per turn from the middle towards either end. The value of the p.d. determined as above gives us an upper limit to the p.d.—*i.e.*, the actual p.d. required to produce the given currrent will never exceed that calculated by the above method.

Could you give me particulars as to how to proceed in testing a circuit for leakage, also the coupling up to the testing apparatus? The circuit is for 500 volts continuous current.

There are numerous forms of apparatus for carrying out insulation tests, and the arrangement of connections will depend on the particular form of instrument employed. The testing voltage may be obtained either from the mains, or from an independent source, such as a portable magneto-generator wound for a high voltage. Perhaps the simplest test is that in which only a single instrument—a milli-ammeter—is used, and in which the voltage of the mains is made use of. To fix ideas, suppose that the negative side of the 500-volt system is earthed (as would be the case with a traction circuit), and that it is desired to test the insulation of a certain cable. The cable having been isolated from the system, its core is connected to one terminal of the milli-ammeter, the other terminal being connected to the positive main. A circuit is now formed from the positive main through the milli-ammeter and the insulation of the cable to earth and so to the negative main (which is earthed). Let i be the current, in *amperes* (so that if the scale of the instrument is marked in milli-amperes, the reading will have to be divided by 1000 to reduce to amperes), which flows round this circuit. Then $\frac{500}{i}$ gives us the insulation resistance required in *ohms*. In order to prevent accidental damage to the milli-ammeter when the insulation resistance has a very low value or when owing to some mistake the cable has not been properly isolated from the system, it is advisable to commence the test in all cases with a suitable safety resistance—consisting, say, of a number of incandescent lamps in series—between the positive main and the milli-ammeter, and to cut these out gradually when it is found that the insulation is sufficiently high.



The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON.

(Continued from p. 207.)

IN taking the points of d.c. motors for lift, crane, and car work, the first item for the electrician is that of the controller. The actual motor connections are almost the same as for ordinary motor work, but it becomes necessary in the class of work we are now dealing with to have a controller so arranged that acceleration is very steady and reversing is allowed for.

These appliances will be found to be of most varied design, but the overlying principle remains the same. To grasp the methods of wiring for controllers it is necessary for the wireman to get a "hang of the thing," after which he will find the wiring connections are very easy to follow out. It would not be possible to illustrate the many systems that are in use in the small space at command. The fundamental principles are, on the one hand, to so regulate the speed of the motor by means of resistance and, on the other, to be able to reverse the direction of the running as required.

In the case of lifts it will be found of universal necessity to obtain diagrams from the makers, owing to the extreme differences in construction that are to be met with. Every maker of electric lifts seems to set out to find some fresh or different method of control, and the result is somewhat confusing. It has until just lately been the usual thing to adopt some arrangement of dash-pots and magnets for operating the resistance in starting lift motors to secure the slow action considered essential. Now many firms have set dead against these methods, and very reliable apparatus is being turned out wherein these appliances have been abandoned. Instead, we have ordinary slow motion worm-gear starters, and in most cases the objectionable starting jerk is absent. Fig. 22 shows an "Aston" controller with connections as for a shunt-wound motor operating a lift. The connections both on the controller and starter are of the simplest.

Fig. 23 shows a similar apparatus with connections for a compound-wound motor. In the latter case the series coils are cut out automatically on the last stop when the motor has reached full speed.

We can next have a look at the very latest thing in lifts and one that bids fair to abolish its older brother in a short time. That is the push-button controlled lift. The illustration shown by Fig. 24 is of the now well-known "Richmond-Carey" system.

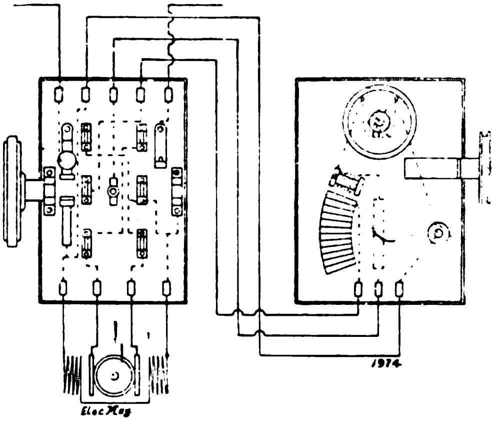


FIG 22.

Unfortunately a large number of people are afraid of lifts, and the general use of the elevator has been restricted by this fear. In the case of these automatically-controlled lifts one cannot see the possibility of any accident occurring. The few points that will appeal to the wiremen who have to deal with them is that notwithstanding the many points from which these lifts can be controlled, yet the wiring arrangements are quite simple. The mechanical points can be summed up in the fact that you cannot do anything you ought not to do with the lift. For instance, you cannot open the door on any floor unless the cage is opposite to it; then, while you have the door open you cannot start the lift; then again, to prevent, say, someone on the second floor from starting the lift before you have time to do so on the third, there is a stop button that throws every button but your own out of use.

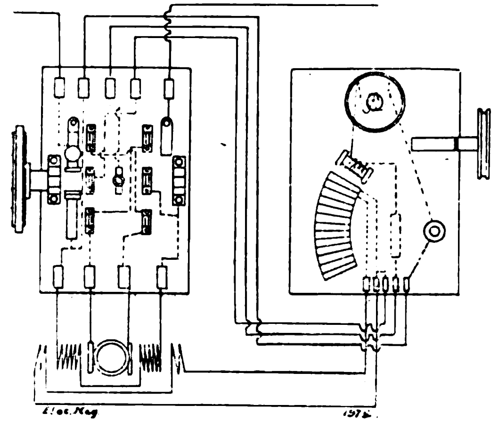


FIG. 23.

But in all such special cases as this it will be found an easy matter to get the working drawings from the makers, and all that need trouble the wireman is the usual form of regulator.

(*To be concluded*)

* * *

Worth Noting!

Foremen and others wishing to augment their income without in any way interfering with present employment would do well to write for particulars to "Amsoc," c/o THE ELECTRICAL MAGAZINE, 4, Southampton Row, London, W.C.

N.B.—No fees of any kind.

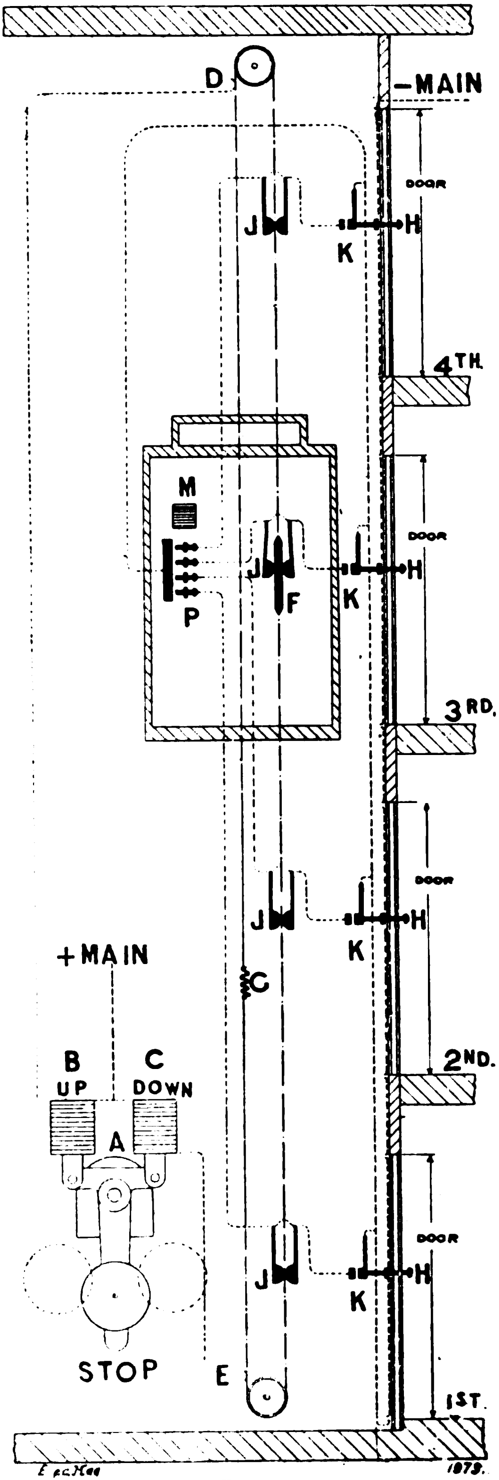
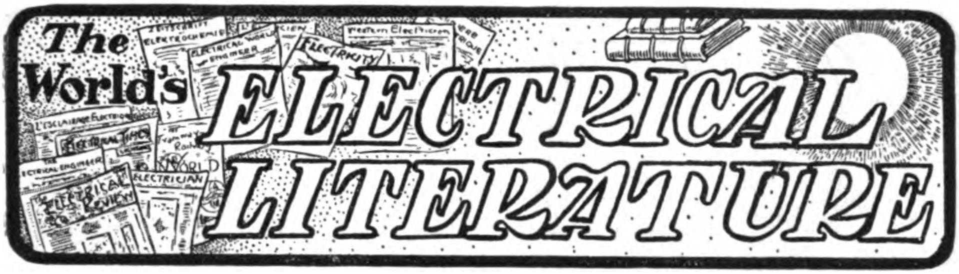


FIG. 24.



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* * *

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Electrical Equipment of Wanamaker's New York Store.	*Elec. Wld.*, 31/3/06.
Electricity in Coke Manufacture. H. S. Knowlton.	*Elec. Rev.*, N.Y., 10/3/06.
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Drying Sand for Rails in the Borough of Manhattan. W. B. Reed.	*Strt. Rly. Jrnl.*, 31/3/06.
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Bow Collectors for Tramways.	*Elec. Eng.*, 23/3/05.
Standardizing Trucks. W. L. Boyer.	*Strt. Rly. Jrnl.*, 3/3/06.

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Public Service Motor Transport. W. W. Beaumont.	*Auto. & Cycle Eng. Inst.*, 28/3/06.
Motor 'Bus v. Electric Tramways. E. Manville.	*Automobile Club*, 29/3/06.

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Smoke Prevention in the Modern Power Station. J. B. C. Kershaw.	*Power, Mar.*/06.
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Boiler Efficiency Tests. G. T. Hanchett.	*Elec. Wld.*, 3/3/06.

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Arc Headlights for Interurban Railways	*Strt. Rly. Jour.*, 31/3 06.
Lighting of Miscellaneous Rooms in Residences. J. R. Cravath and V. R. Lansingh.	*Elec. Wld.*, 3 3/06.

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Storage Batteries in Telephone Work. F. R. Hoyt.	*Telephony. Mar.* /06.
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Insulation a Factor in Telephone Exchanges. C. H. Coar.	*Telephony. Mar.* /06.
Lightning and Static Protection. R. C. Cutting.	*Telephony, Mar.* '06.
Telephone Rate Problems in Boston. H. S. Knowlton.	*Elec. Rev.*, N.Y., 3/3/06.
The Automatic Telegraph a Public Utility. R. Hitchcock.	*Teleg. Age, Mar.* /06.

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Lightning and the Electricity of the Air. A. G. McAdie.	*Jrnl. Elec. Power & Gas, Mar.* /06.
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Healing Effect of the Electric Spark. H. A. Perkins.	*Elec. World*, 24 3/06.

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Unilateral Conductivity Over Damp Surfaces. F. T. Trouton.	*Phys. Soc.*, 23/3/06.
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Circle Diagram of Compensated Series Single-phase Motor. E. C. Stone.	*Elec. Wld.*, 24/3/06.
Iron Losses in Single-phase Commutator Motors. F. Neithammer.	*Elec. Wld.*, 24/3/06.
Starting Torque of Induction Motors. R. E. Hellmund.	*Elec. Wld.*, 31/3/06.
Commutation of Single-phase Motors at Starting. M. Latour.	*Elec. Wld.*, 10/3/06.
Calculation of Dynamo Sparking Constants. A. Press.	*Elec. Wld.*, 10/3/06.

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Determination of Sags in Wire Spans. R. J. C. Wood.	*Jrnl. Elec. Power & Gas, Mch.*/06.
Slide Rule as a Substitute for the Wire Table. C. P. Nachod.	*Elec. World*, 3/3/06.
Centrifugal Pump and its Application. H. Y. Hayden.	*Jrnl. Elec. Power & Gas, Mch.*/06.
Simple Diagrams for Three-phase Power Calculations. A. Still.	*Power, Mch.*/06.
Design of a Small Power Station. J. F. Hobart.	*Elec. World*, 3/3/06.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

NORTH-EASTERN COUNTIES ELECTRICAL EXHIBITION.

BY OUR SPECIAL COMMISSIONER.

Sir Isambard Owen, in opening the Electrical Exhibition at Newcastle-upon-Tyne on March 24th, dwelt upon the enormous and growing importance of the electrical industry in Tyneside, perhaps of more importance than in any part of the United Kingdom. He had been told that they were the largest consumers per head of the population in any part of His Majesty's dominions, perhaps in any part of the world, and certain developments, such as the establishment of a large new chemical industry, were likely to cause yet a great increase.

He was informed that they could produce electrical power on Tyneside at as low a rate as at the falls of Niagara.

Armstrong College was doing its part, and it was a pleasant coincidence for him that he was asked to open that exhibition just at the time they had established a chair of electrical engineering in the college and that Professor Thornton had been appointed to fill it.

The exhibition may be divided into three classes, the Electrical Supply Companies, the Electrical Contractors, and the Manufacturers, the latter in some instances represented by their local agents.

The supply companies occupied the largest spaces and had a unique and imposing display with the object of showing to their customers, both present and prospective, the varied uses that electrical energy can be put to.

The Newcastle-upon-Tyne Electric Supply Co., Ltd., who have recently amalgamated with The County of Durham Electrical Power Distribution Co., began by showing how their electrical energy is generated at Carville-on-Tyne. They had some splendid models of the actual turbine three-phase generators in use at that station, and a small model of a Parsons turbine opened to show the working parts, with a model of a "Stirling" boiler, photographs of the stations and substations, specimens of mains, jointing boxes, &c. This part of the exhibit was as complete as possible, and both useful and interesting to everyone. A tobacconist's shop front lighted in an ideal manner, a café fumant with electrical cooking utensils, cigar lighter, a workshop with electrically driven tools, electric welder, lift, electric organ, in fact a full description of this exhibit would occupy many pages. This company had also fitted up the electrical cooking lecture room where lectures on cooking were given at intervals.

As the exhibition happened to be in the district of this company—in fact, it was a few hundred yards from the original pioneer station, which is now used as a substation—the whole of the current used in the exhibition was supplied by them at the nominal charge of 1¾d. per unit.

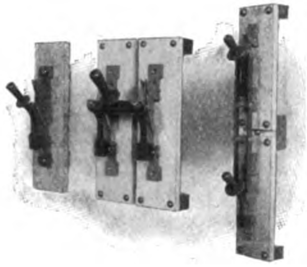
The Newcastle and District Electric Lighting Co., Ltd., showed the application of electric lighting to two shop windows, one a hosier's, the other a silversmith's, and demonstrated very clearly the superiority of the medium in protecting and displaying the goods to the best advantage. Two model rooms, dining and drawing, showed every possible application of the electric lamp to decoration and electric radiators for heating.

The remainder of the stand was devoted

to the application of the electric motor in driving domestic machines, and to various trades—sausage making, cream separating, screw cutting lathe, all being at work.

In fact the supply companies had spared no expense to show the public what electricity can do, and all this without advertising any particular manufacturer.

As the Manufacturers' Association prevented several important firms exhibiting at this exhibition, many of them were indirectly represented by agents and contractors, and this had been the means of giving the local contractors an unusual opportunity, several of them being quite bewildering in the variety of their display.



Holmes-Page Knife Switches.

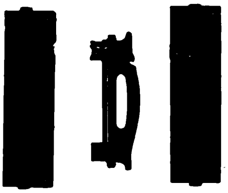
Messrs. Robson and Coleman, contractors, had a stand erected of screwed welded tubing. They showed Aston motors in various applications; one application to the organ blower was very interesting, the supply of air being regulated automatically by the throw of an eccentric controlled by the amount of air in the reservoir. At this stand was working a small electric overhead crane capable of lifting 1 ton 15ft. per minute or smaller weights at greater speeds. This caused much interest and will fulfil a want in many trades. Arc lamps of endless variety were here shown besides the Cooper-Hewitt Mercury vapour lamp, a new 400-hour arc lamp, twin carbon arc lamps, miniature arc lamps, and these together with meters and mains, switches and controllers, formed an exhibit very difficult to exhaust.

Lundell Motor.

Lundell Motors Driving Aerated Water Machines.

Messrs. Falconer, Cross, and Co., who are contractors to the new infirmary in Newcastle, showed the various methods of wiring for power and lighting, a very fine display of fittings, duplex ship's light indicator connected up to a ship lantern shown working; a patent emergency lighting set was very interesting. With various kinds of arc lamps, also the tantalum and Osmi lamps, mercury vapour lamps, and all kinds of motors, controllers, radiators, switchboards, &c., it is difficult to imagine what they did not exhibit in the way of domestic and factory applications. They also showed telephones and electric bells for houses and mines.

Messrs. Thos. Usher and Co., of Newcastle, showed a country house plant, also a sitting room and conservatory lighted by reflected light and warmed by radiators.

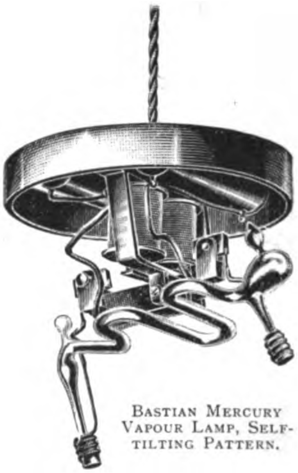


Holmes Removable Fuse and Contact Base.

Messrs. Reid, Ferens and Co., an old firm noted for lightning conductors, as agents for the Electric Construction Co., Ltd., Wolverhampton, showed a variety of continuous and three-phase motors, switches, and electrical accessories.

Of the manufacturers, Messrs. J. H. Holmes and Co., who are the pioneers of manufacturing in the district, had quite an up-to-date exhibit, a new line of recently designed motors, which, whilst competing with other standard machines, are yet capable, without resort to the intermediate commutating poles, of working at a 3 to 1 ratio of speed. They are solidly built, great care being taken in the insulating and also the ventilating of the various parts. A line of Lundell motors—the first, the largest size, being driven from the supply—were then arranged in pairs belted together as motors and dynamos, the motors being driven from the dynamos until the smallest size, ¼h.p., is reached; the latter, acting as a dynamo, lighted up an original "Castle" arc lamp of 1887, taking 1½ amperes in series with an incandescent lamp and an ammeter. The firm also showed one of their well-known ship lighters. A Holmes-Clatworthy printing set and a variety of measuring instruments, including recording voltmeters, ammeters, and wattmeters, all constructed by the firm; automatic starters, search-lights, induction three-phase motors, and many other things too numerous to mention completed this interesting exhibit.

The Sunderland Forge and Engineering Co., Ltd., Pallion, Sunderland, had a very excellent exhibit. An enormous crab for a four-motor electric crane was a most interesting feature, and showed what the firm can do in the way of heavy engineering. A portable electrical saw bench was a speciality, and contained some unique features. A centrifugal pump, three ship-lighting plants, entirely constructed by the company, induction motors, and an electric winch, with several other details, made up an exhibit that was much admired by the many engineers who visited the exhibition.


Bastian Mercury Vapour Lamp, Self-tilting Pattern.

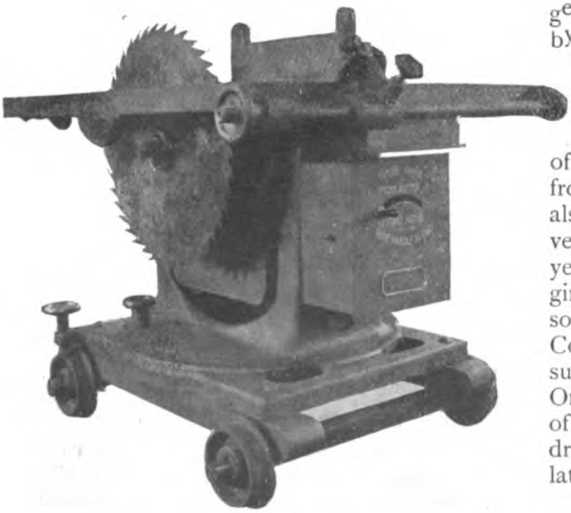
Naturally in a colliery district of such importance as Newcastle, mining machinery should be well represented. Electricity holds a place in nearly every important colliery. Messrs. Frank Pearn and Co., Manchester, showed a number of pumps, including a treble ram, 6¾in. diameter, 12in. stroke, capable of delivering 12,000 gallons per hour, head pressure 470ft., driven by a three-phase induction motor.

Messrs. W. H. Allen, Son, and Co., Bedford, had a variety of pumps on view. One of the turbine centrifugal description for 500 gallons per minute at 200ft. head when running at 1500 revolutions per minute has revolving discs of cast iron and guide blades of cast steel. The firm also exhibited a ship plant.

The Brush Electrical Engineering Co., Ltd., London, exhibited a coal-cutting machine with a disc cutter; it has two 15-b.h.p. motors working through helical gearing enclosed in an oil bath and protected by a gas and dust tight case.

Another electric coal cutter was exhibited by Messrs. Crozier, Stephens, and Co., Newcastle-upon-Tyne, which had the cutters arranged on an endless chain; it is of the "header" type and is capable of cutting from 4ft. to 6ft. deep by 44in. wide. They also exhibited a rock drill. The firm had a very extensive exhibit. For more than twenty years they have furnished the electrical engineering industry with supplies of various sorts. As agents for the British Aluminium Co., they showed a variety of products, such as castings, alloys, sheet strip, &c. On their stand could be seen a great variety of applications of the electric motor, portable drilling machine, motor-driven capstan, lathe, planer, wood-working machinery, &c.

In connection with colliery work, Messrs. J. H. Holmes and Co. showed a double pole


Sunderland Forge Motor Saw Bench.

CROZIER-STEPHENS PORTABLE ELECTRIC DRILL IN USE.

switch and fuses mounted in a gas-proof cast-iron box on a pillar; the door of the box can only be opened when the switch is off.

Messrs. Mavor and Coulson exhibited a three-phase "Longwall" coal cutter especially designed for thin seams.

The Industrial Engineering Co., of Hyde, Manchester, had an exhibit of motors and dynamos. The small machines have cast-iron yokes, steel poles with shaped laminated pole faces let into the steel, and are very neatly designed.

Messrs. H. T. Boothroyd, Hyslop, and Co., Bootle, showed ship plants and fittings.

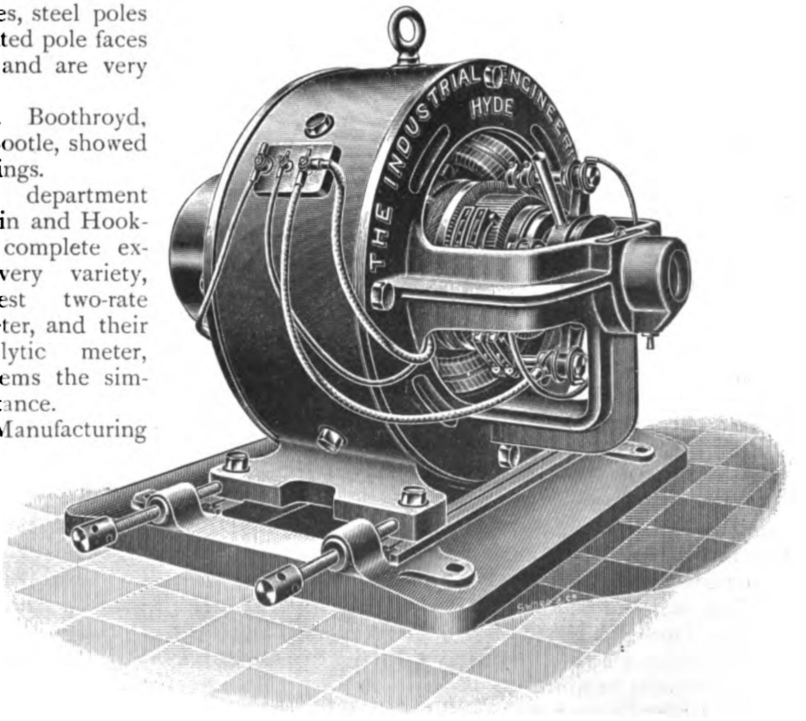
In the meter department Messrs. Chamberlain and Hookham had a very complete exhibit showing every variety, including the latest two-rate meter, the slot meter, and their ingenious electrolytic meter, which certainly seems the simplest meter in existance.

The Reason Manufacturing Co., Ltd., of Brighton, had a great display of their meters, demand indicators, slot meters, and also an electrolytic meter; they also showed arc lamps, street lighting fittings, fuse boxes, &c.

Mr. James Gledson, Newcastle, represented a number of well-known firms, and his exhibit was crowded. Instruments from Messrs. Elliott Bros.; motor dynamos, &c., from Messrs. Laidlow, Laidler, and Co., Manchester, also various instruments from Messrs. Santoni, C. A. Muller, The Sunbeam Co., and various others.

Messrs. Lucy and Co., Ltd., Oxford, showed frequency tellers, Frahm's speed indicators and revolution counters, also time switches for staircases and other uses, and a variety of switches, fuses, &c.

In the way of lighting, flame arc lamps were used in various places about the building, and the Bastian mercury vapour lamp, of which the agents are Messrs. Sleigh and Wood, was shown at various points. A small room lighted by this lamp by reflection from a white ceiling and an underrun incandescent lamp to provide the red rays was very effective and showed great economy of current.



INDUSTRIAL OPEN-TYPE MOTOR WITH BED-PLATE AND SLIDE-RAILS.

The Sunbeam Company had some cases distributed amongst the contractors, and Mr. C. Faraday Proctor exhibited a case of incandescent lamps which showed the evolution of the glow lamp from the first and epoch-making lamp of Swan onwards. In this connection, some very old lamps of various makers were shown by Mr. J. H. Holmes, which could be seen on the firm's stand.

Electric lifts were represented by Messrs. Austin and Co., Newcastle, who showed a passenger lift, electric sack hoist, &c., all of their own manufacture. Messrs. Waygood and Co. had a passenger lift exhibited on the Newcastle Electric Supply Co.'s stand.

There were many other exhibits all of which had some bearing directly or indirectly on electricity. It was the intention of the Advisory Board to have had lectures, and arrangements had been made with local men for that purpose, but the demand for space was so great that no place for a lecture room could be found.

There was a large and interesting loan collection of historical instruments from the General Post Office, telegraphic instruments from 1837, early telephone specimens of Caole, &c.

The exhibition has already justified its existence; the supply companies are quite satisfied with the results even up to the present, as an exhibition with such an infinite variety of applications must increase the interest of the people. Although electric cooking, domestic motors, and radiators may at the present time be luxuries, yet everyone is looking forward to the time when they will be universally used, the gain in cleanliness and health being self-evident. Already there is a rumour of current at a penny per unit for such purposes as just mentioned, and such a price will greatly help to popularise these applications.

Local exhibitions have somewhat got out of repute and are often spoken of as not paying the exhibitors, but Tyneside is a peculiar district; it is estimated that there is a population of about 2,000,000 people in the towns in the neighbourhood, and the amount of trade done is very great; nearly every manufacturer is represented directly or indirectly in Newcastle.

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Manufacturing Notes.

Papers for Electrical Trades.

We have received from Messrs. Allen, Strong & Co., Ltd., paper merchants, 17, Bread Street Hill, Upper Thames Street, E.C., a substantial packet of samples of their papers for electrical work. Paper now so largely constitutes the bulk of the insulation of electrical conductors that considerable care must be taken in its selection. The grades of paper represented by the samples sent us point to most thoughtful classification, while to meet the convenience of customers at least twenty varieties are stocked in London, and can be supplied by return. Those interested in insulating papers should apply for samples, as the quality of the specimens supplied to us points to very superior manufacture and finish.

Nernst Lamps.

We have received from the A.E.G. English Manufacturing Co., Ltd., the following letter, which points to a healthy state of things with Nernst lamps in the Argentine: "Dear Sirs,—We have pleasure in informing you that on December 31st, 1905, we had 9750 of your A and Luna type in use on direct current of 225 volts and three-phase current of 225 volts. We also have several thousands of your B type Nernst lamps on our circuit, but cannot give the exact number, as our consumers use them in the place of ordinary glow lamps. Our experience with Nernst lamps is very satisfactory; they have been of immense value to us in meeting the competition of incandescent gas. For street lighting also we have used Nernst lamps with complete success, especially in streets where arc lamps are too powerful.—Yours truly, Compania Alemana Transatlantica de Electricidad, Buenos-Aires."

The
Electrical Magazine.

FOUNDED AND EDITED BY
THEO. FEILDEN.

Vol. V. No. 5. (29th Issue.) London. May 16, 1906.

The World's Electric Progress.

Earthquake and Fire.

The earthquake disaster at San Francisco has been horrific in all conscience, but, speaking from the facts as they are now before us, the bulk of the damage was done by fires subsequent to the fall of the buildings. Judging by reports, gas seems to be mainly responsible for the outbreaks, as the bursting of the huge pipes would release many thousands of cubic feet. Had San Francisco depended solely for light and power upon electricity we are convinced the fire terror following the earthquake would never have been experienced, and much valuable property might now be still unharmed. We hope that in the reconstructed city gas will not be allowed an entrance especially if substantial evidence is produced by which the fire can be fixed upon this particular public service. Earthquakes no man can control, but their consequences can in some measure be mitigated. Steel buildings are to be had which will withstand earth tremors, and precautions are possible to prevent conflagrations when buildings are shaken to the ground. San Francisco, before any city, is in touch with natural power sources which would, if properly applied, make it the foremost electric city in the world. Gas, coal, coke, and wood fires need find no place within its walls when cheap transmitted electricity is so near at hand. Nature has stepped in and shaken this fair city of the West as if to awaken it from slumber and summon it to the task of casting out all that threatens its citizens' welfare. Let us hope her teaching will not be lost on the men whom, while she admonishes, she endows with the means of defence against the consequences of her chastisement. May we soon point to San Francisco as *the* electric city of the world.

M. Pierre Curie.

Nature is jealous of her secrets and grudgingly gives them up to enquiring humanity. She also exacts a heavy price which must be paid by most investigators. Can it be that M. Pierre Curie's untimely death was something more than an accident? We shall never know, but certain it is the world of science will feel his loss, and heavily. An investigator of the keenest intellect into phenomena taxing the mental powers to the utmost, he succeeded in a few short years in bringing to a climax the results of much of the disjointed labours of many distinguished predecessors, and, by his untiring application, founded a new branch of modern science, that of radio-activity. That he should suddenly be snatched from the scene of his life's best work in a moment seems like the irony of fate, and at a time when, may be, some startling development was matured in his active mind. Since the discovery of radium by himself and his wife, our knowledge of physics has advanced to a point which at one time could not have been credited, and the clue to many other important discoveries is now in our possession. The deceased scientist was only forty-seven. Our sincere sympathies are extended to his bereaved wife, while we bemoan the loss which humanity sustains in the untimely end of so promising a worker on its behalf.

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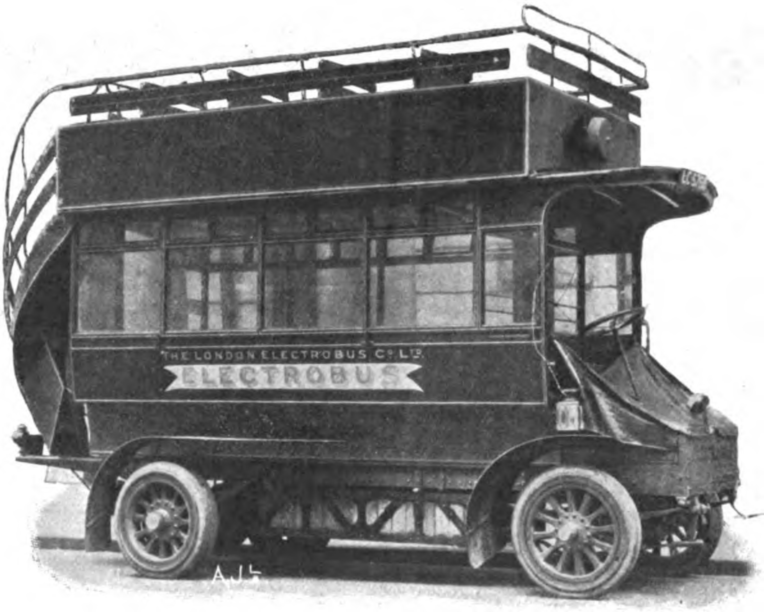
Illuminating Engineering.

We hope that those of our readers who desire to see the cause of good illumination advanced in this country will respond heartily to Mr. L. Gaster's appeal for help in the formation of a British Illuminating Engineering Society. The reasons for the taking of this step have frequently



By permission] [*of the Automotor Journal.*

GENERAL VIEW OF THE ELECTROBUS.

been put forward in these columns, and Mr. Gaster's article, concluded this month, sums up the situation exactly. No time should be lost, as the present position of illumination demands co-ordinate interest and co-operative effort for its establishment on an authoritative basis in this country. America has led off well. Already it can boast a society and an independent journal devoted to the subject. The state of affairs here needs both of these, and just as soon as they can be fashioned from the materials at disposal. We want the gas and oil men as well, and hope they will stand by the movement, as their interests are likely to be safeguarded equally with those of other illuminants represented. We have now done with the talking. The sooner the practical business is got down to the quicker the end in view will be attained.

* * *

The Electrobus.

FROM events which have transpired since our last issue, an assault is to be made on the positions now occupied by steam and petrol 'buses for city traffic. The most natural assailant is electricity, and if its campaign can be generalled in the right way it will carry the positions by storm. The London Electrobus Co., Ltd., is the first division to take the field, and from a private inspection we were afforded, with a party of journalists, of the advance guard, some brisk skirmishing should result when hostilities are declared. Mention of an electric 'bus to any electrical engineer at once draws the question, "What make of battery?" and this query was put to the promoters of the scheme by every technical journalist invited to the trial run. No direct information was vouchsafed on this important section of the equipment, the entire responsibility of supplying and maintaining the cells being a matter of contract with the makers. The 'buses are to have four changes of batteries during a day's run of 120 miles, and the first service is to be between Victoria Station and King's Cross. The equipment calls for no special comment. A 44-cell battery, of X make, supplies the electrical energy, and a two-commutator motor of 12-14h.p. drives the 'bus. It is placed between the two front wheels, below the driver's seat, and drives through chain and propeller shaft on to the back axle. The illustrations we give of the 'bus and its chief parts are reproduced through the courtesy of the *Automotor Journal*, who kindly lent us the blocks. From these views a good idea can be gained of the appearance of the 'bus and of the motor and controlling gear. Up to the present only the most fragmentary evidence can be obtained as to the battery makers and their guarantees, and until the 'buses are on the road nothing can be said about their realizing the high hopes of the good performance entertained by the principals of the company. It is certainly to be regretted that the fullest possible information was not given the technical Press, which is pre-eminently fitted to deal with anything in the shape of innovations in a thoroughly impartial manner. The promotors of the company have been subjected to sharp criticism on this account, by both the technical and lay Press, and we hope they may profit by it and make known details the withholding of which seriously prejudices their interests in the eyes of the public. We may certainly expect to say something more about electrobuses in an early issue.

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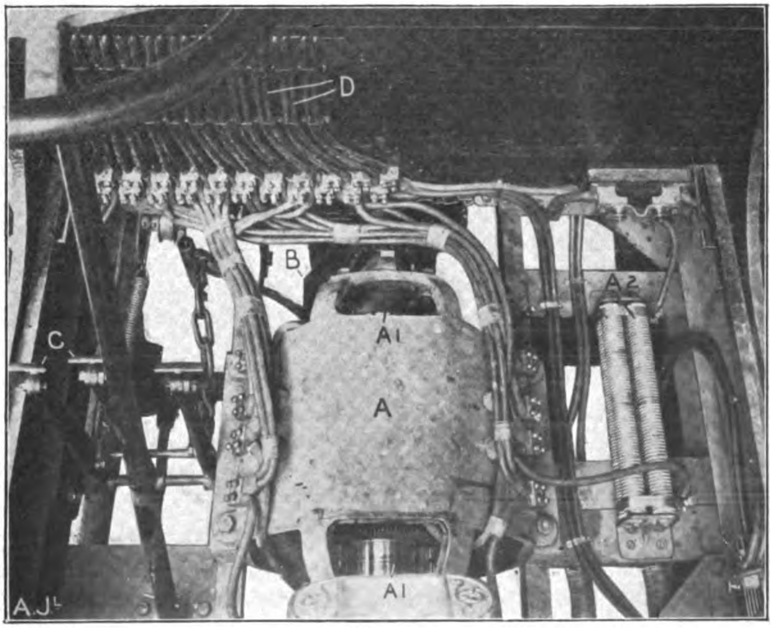
Electrical Music.

OUR ideas of music are closely associated with vibrations, but hitherto suggestions only have been made for the electrical production of vibrations corresponding to notes familiar to the ear. A system embodying many unique features and dependent on the principle of electrical vibrations has now reached the practical stage and is being rapidly developed for commercial purposes. It is the invention of Dr. Cahill, of New York, and comprises a battery of alternators of different frequencies producing currents which are controlled by numerous keys, and which operate a number of telephone receivers fitted with large horns. The alternators are so arranged that the notes can be produced through five octaves. By means of the large receiver horns the sounds produced are much magnified, and are audible equally well at a distant station as when connected to a few feet of wire. The keyboard gives complete control over the sounds produced, and accurate expression can be given to the various harmonies. The idea of the inventor has been to provide a means of distributing music over great distances by the simplest possible method, and from the descriptions we have so far seen of his apparatus, he has certainly succeeded. We are informed that the system is soon to be introduced into this country.



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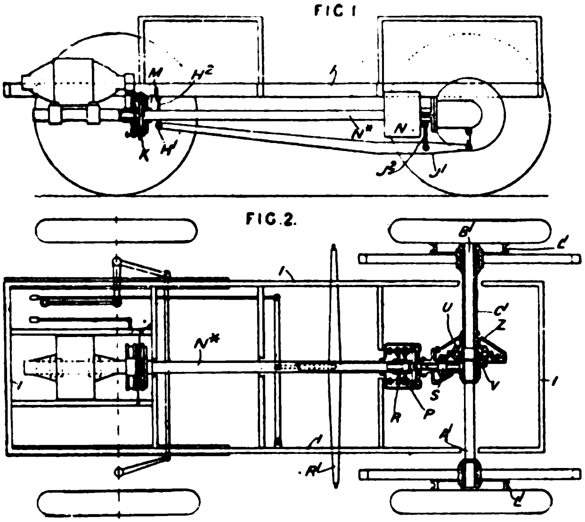
MOTOR AND CONTROLLER OF THE ELECTROBUS.

A. Motor.
A1 A1. Commutators.
A2. Resistance.
B. Driving Chain.
C. Steering Column.
D. Controller.

FIG 1

FIG.2.



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ELEVATION AND PLAN OF CHASSIS OF THE ELECTROBUS.

The Tramway Park.

LOCAL conditions play a prominent part in the policy adopted by tramway undertakings to stimulate business. In this country we have good roads to reach rural districts and fine scenery, and in addition the chief pleasure resorts are only a few hours' railway journey from populous parts, so that ready-made sources of delight are always constantly to hand. A huge country like America, however, has to manufacture local amusement to attract the people out of the towns during the brighter months of the year, and the successful extent to which this idea has been carried is evidenced by the popularity of the tramway park. This latter term is taken from the fact that the place of amusement is located outside the town and can only be reached by way of the trams, which put on special services to encourage traffic. The tramway park has thus become an institution in the United States, and at this time of year the fact is more strongly emphasised by the business campaigns which "amusement caterers" are conducting to obtain the support of park managers all over the country. We notice from our American contemporaries that there is to be a boom in roller skating this year in the tramway park business, and makers are now running night and day in the endeavour to complete their many orders. We are informed that there are at the present time from twelve to fifteen hundred flourishing skating rinks in the States, and this number is being very rapidly added to. Things are conducted on such different lines in this country that it is very unlikely that the tramway park could be made popular. It is not entirely a matter for the tramways manager, but one in which the support of the public must be sought after and won. The British public is not so easily amused with roundabouts, circle swings and scenic railways, and it would be a doubtful speculation if a tramway park, on strictly American lines, were opened near a large town, ostensibly with the intention of encouraging people to ride on the trams. Still there is something to be said for the principle, and an experiment will be worth making, after a careful study of the local temperament, to ascertain the support such a scheme would be likely to receive. We should certainly profit if some of the ideas of American tramway practice in getting business were adapted to the needs of the particular localities operating a tramway service in this country.

A Record of British Electrical Enterprise.

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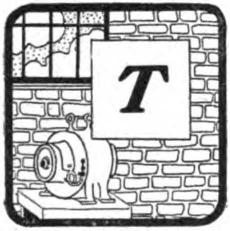
POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

* * *

One Machine—One Motor.

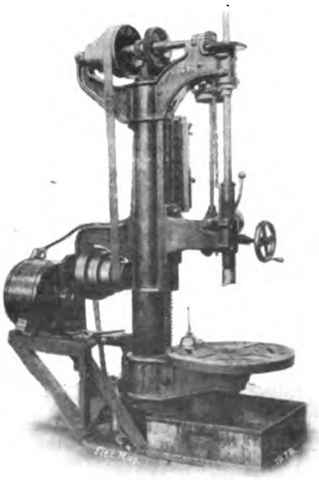


The ideal of the individual motor drive will take time to find full expression in practice, but there are strong indications that it will ultimately be generally accepted. One machine—one motor, that is what it means exactly, and there are few difficulties in the way of its accomplishment. The reduction of manufacturing cost in the production of the electromotor is leading power users in the desired direction, and when a certain point is reached it will be merely a question of time to ultimately attain the end now in view.

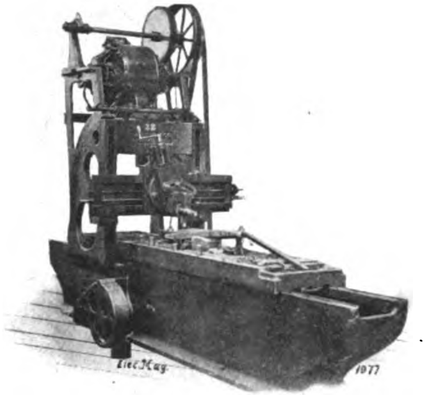
Standardization of certain classes of drive has certainly at this moment been effected, and in such cases nothing but this particular form of individual motor application is specified and installed. The settlement of motor drive in this way will do more to encourage the use of electric power than the haphazard installation of motors, merely for the sake of getting them in. Apart from the matter of quick delivery there is the influence on the prospective user's mind of the stability of a power agent which can be thus adapted to industrial purposes.

The economical pros and cons of the individual motor drive have not, it is true, been thoroughly threshed out in their relation to industry as a whole, but they are beyond dispute in certain specific branches of industry, and the principle has now passed into the realms of the common-place in those spheres. In no case is this better exemplified than with machine tools, and the illustrations in this section this month may be taken as typical of present practice in this field. They represent the application of separate motors to common types of tools such as might have been operated from line shafting. The titles to the views supply all the information necessary.

A factor bearing closely on the installation of a motor for each machine is the generally improved design of the modern factory or engineering works. Buildings almost palatial in arrangement and substantial in construction seem fitted to shelter from the elements something better than the clumsy, ugly and noisy line shaft, pulley and belt. These were well enough in tumble-down wood and tile "shops," but they are not



Drilling Machine operated by Separate Motor Driving through Gearing and Belt.



Planing Machine driven by individual Motor, through Gearing and Belt.

fit to grace the steel columns and brilliant aisles of a twentieth-century workshop. What may be termed the efficiency of the building is now reflected in the equipment it contains, and the two combine to produce, to say the least, a harmonious result.

* * *

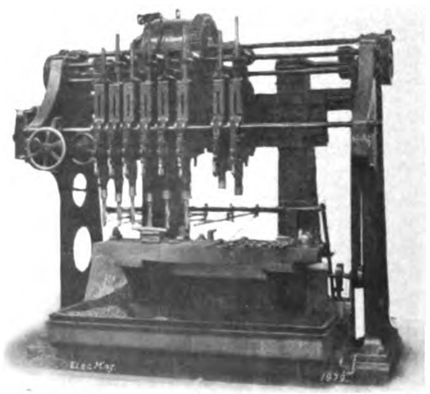
Niagara-Syracuse Transmission Line.

The greatest power transmission line this side of the Rocky Mountains is being built between the Niagara border and the city of Syracuse by the Niagara, Lockport and Ontario Power Company, its length being about 160 miles. While the line has the above-mentioned length in New York State, there are also about four miles of towers and cables on the Canadian side of the river, for it is contemplated that power generated on the Canadian side shall supply the line. According to report, a great deal of this transmitted Canadian Niagara energy is to be applied to the operation of present steam railroads in the western New York section, which are to be electrified. This includes portions of the New York Central and the old West Shore between the Niagara border and Syracuse, while electric roads in the cities referred to will be able to obtain power from the line if they so desire. This will place the various managements in an exceptional position when they finally decide to run electric trains over these routes. It will also hasten the conversion from steam.

In all agreements made between power companies and the commissioners of Victoria Park, it is specified that all of the power developed must be transmitted outside of the park boundaries for use and application, the agreements permitting the transmission of at least one-half of the power developed to be transmitted to the United States, but on demand one-half must be available for use in Canada at prices similar to those charged for the same power in the United States for similar uses. The Governments of the United States and the Dominion of Canada do not place an import or an export duty on electrically generated power.

From the distributing station on the bluff to the rear of Victoria Park a line of steel towers extends northward, a short distance back from the river, to a point four miles down the gorge, where the transmission line crosses the river. At the edge of the Canadian bank the cables, which are of aluminum, drop to cantilever arms projecting over the edge of the bank. There are nine cables, each having 19 strands of No. 5 wire, and from the cantilever arms the cables drop to steel towers erected close to the water's edge. From these towers they swing over the river, the span being about 600ft., to similar towers erected on the New York shore. Then they pass up the bank to cantilever arms at the top of the cliff on the New York side, and then to poles and steel towers.

Steel towers will carry the cables as far as Rochester, and from there to Syracuse wooden frames made in the shape of the letter A will support them temporarily along

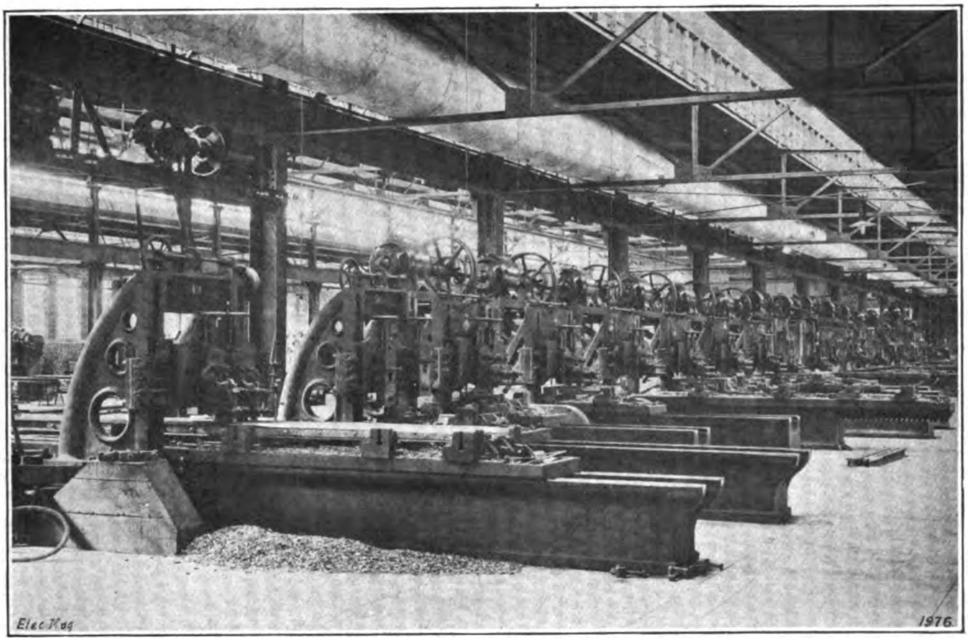


Multiple Vertical Drilling Machine, Operated by Separate Motor which is contained within the Body of the Machine.

the West Shore Railroad right of way. There will be about 1500 steel towers and 2500 A frames. The steel towers have a height of 55ft., and at a height of 45ft. there is an arm. Insulators are placed at each end of the arm and at the apex of the tower, each insulator being about 28in. high and weighing about 75lb. The insulators are the largest used in a Niagara transmission, and have two petticoats and a hood, the latter having a diameter of about 14in.

In running through western New York this transmission line is being built south of one set of towns and cities and north of another section, so that it will be possible by running short branch lines to give an excellent service in either direction. The power will be applied to the operation of trolley lines, of industrial plants, and for lighting purposes where needed. It is expected that the transmission line will be ready to deliver its current some time during the coming summer, as the power-house is now ready to supply the line, and the big distributing station is having its transformer equipment placed in position.

When in operation it will be the longest power transmission in the East, and its operation during the various seasons will interest engineers to a considerable extent, as it is well known that the longer transmissions in the West have advantages in climate and weather not possessed by this Eastern work. Up to this time the longest transmission of any great amount of power from Niagara is to the city of Buffalo, the distance being about 25 miles, so that carrying Niagara power to Syracuse, about 160 miles away from the generating station, will be quite a different accomplishment.—*Electrical World.*



A LINE OF ELECTRICALLY-DRIVEN PLANERS EACH HAVING ITS OWN MOTOR AND STARTING GEAR.

Transmitted Gas Power.

SINCE the services of coal were requisitioned to raise steam and thus indirectly aid in the commercial production of electrical energy, the electrical engineer has withstood the steady stream of denunciations poured upon his adherence to such circuitous methods. Of late years the idea of gas power has been gradually suffered to mature, and there are periodical "breakings out" by enthusiasts on the subject of gas transmission from the coal fields to populous centres for utilization. The latest contributor to the known data on the subject is Mr. A. J.

Martin, who puts his views into a long and instructive paper, which he presented to the Society of Arts. As this fills some twenty pages of the journal of that body, we can only take abstracts from it, though the entire document will bear careful study by engineers interested in so important a problem. Mr. Martin sees a national danger not only in the waste of coal, but also in its employment in the crude manner known to our time. Referring to the use of nitrate of soda, now imported from Chili, as manure for wheat cultivation, he says: "There is an alternative manure for wheat land, namely sulphate of ammonia, which is one of the chief by-products in the manufacture of gas from coal, and contains nearly 30 per cent. more nitrogen than is present in nitrate of soda. While we now spend £15,000,000 per annum in getting nitrate of soda from Chili, we waste at least an equivalent amount of nitrogen by our primitive methods of using coal. The depletion of our coal mines not only brings us daily nearer to a coal famine, but is at the same time steadily breaking down our last barrier against starvation."

A table was given among the other valuable matter, which shows at a glance the present enormous waste of energy resulting from the improper use of coal. We give this table below.

—	Consumption in Millions of Tons.	Saving in Millions of Tons.	Means of Economy.
Railways	12 to 14	5 to 7	Gas Generators and Engines and Electric Motors and Traction.
Steamers	6 ,, 8		
Factories	40 ,, 45	20 to 30	
Mines............	10 ,, 12	5 ,, 7	
Blast Furnaces ..	16 ,, 18	2 ,, 3	Gas Engines and Recovery Ovens.
Iron and Steel Furnaces	10 ,, 12	2 ,, 3	
Other Metals	1 ,, 2	—	—
Brick Works, Potteries, Glass Works & Chemical Works	4 ,, 6.	1 to 2	Gas Generators and Coke.
Gas Works	14 ,, 15	—	Gas Cooking and Heating Briquettes and Coke.
Domestic Fires ..	30 ,, 36	5 to 8	
	143 to 168	40 to 60	

Mr. Martin's subsequent arguments all favour the supply of compressed gas by pipes from the coal fields to the great social and industrial centres and its utilization there as gas, in gas consuming apparatus. His scheme has every appearance of practicability, though some speakers in the discussion thought otherwise, but we should much have preferred that the transmitted gas be converted into electrical energy at the terminal end and distributed as such to consumers. The all-round advantages of electricity cannot be overlooked, and it is moreover a mistake to pass them by as of no consequence.

Mr. W. H. Booth, in an article on the subject of electric power for London contributed to our esteemed contemporary *Electrical Industries and Investments*, treats with the power generator at the coal pit in a different way, and his remarks are worth quoting in full. Speaking on the generation of electricity at the mine he says: "The question now arises as to motive power. Gas engines of large size should be employed for this purpose, and they should use what is now known technically as power gas—that is to say gas consisting largely of carbonic oxide, and not containing more than, say, 5 per cent., or at most 8 per cent., of hydrogen. At the same time the high-priced by-products such as tar and ammonia must be preserved and not burned. To this end the coal must first be carbonized in recovery ovens, and the rich distilled gas must be suitably freed from those valuable products tar and ammonia, which will reduce the cost of coal by from 3s. to 4s. 6d. per ton. The coke produced must then be converted into gas by the dry-blast producer, the gas from which is almost entirely carbonic oxide. This gas is mixed with the purified oven gas to the required limit of hydrogen for use in the gas engines. By the use of such gas as this it is possible to work a large gas engine with a high degree of initial compression whereby alone the gas engine is enabled to work with the economy that ought to be secured." It will be interesting to see if the special "hybrid" committee sitting on the London Power Supply question will recommend transmitted gas or electricity for consumption in the Metropolis.

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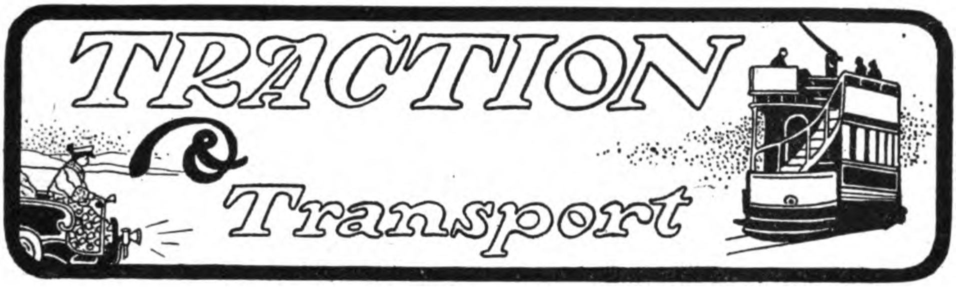

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

The Ward-Leonard System on its Defence.

We are very pleased to see that Mr. Ward Leonard is coming out into the open in defence of his excellent one-phase railway system. In the columns of the *Street Railway Journal* he openly challenges Mr. B. G. Lamme to produce data and curves of actual performance, efficiency, &c., of his New York-New Haven locomotive, which shall be published in the same issue as figures relating to his system as developed by the Oerlikon Co. We have from time to time remarked upon the claims of the competing methods of electric railroad traction, and, while disposed to favour one-phase working, have always had a particular leaning towards the Ward-Leonard system. During the booming of commutator motors their advocates have not lost opportunity to cast aspersions upon the system, adopting the "damned with faint praise" policy, which is more galling than open attack. The eminent inventor of the system remarks in his letter, which is written to answer Mr. Lamme's side thrusts, "a Ward Leonard-Oerlikon locomotive capable of exerting 800h.p. maximum output, measured at the rails, has a total weight of 97,000lb., all on the drivers. There are 121lb. on drivers per horse power at the rails, based upon the maximum output, which compares favourably with the best modern freight locomotive practice, in which there are about 125lb. on drivers per indicated maximum horse power in the cylinders. The present selling price of a Ward Leonard-Oerlikon locomotive f.o.r. works is about tenpence per pound if only one is ordered. I estimate that if locomotives of the Ward-Leonard type should be manufactured in large enough quantities to make comparisons with steam locomotives fair, the price per pound would be 4$\frac{7}{8}$d., which I arrive at as follows:—

	Pence per lb.
Motor Generator	5
Propelling Motors	6
Average of Total Electric Equipment	5$\frac{3}{4}$
Trucks, Driving Axles, &c. . . .	3$\frac{1}{2}$
Average of Total Locomotive when made in large numbers	4$\frac{7}{8}$

Mr. Ward Leonard scores a decided point in his reference to the multiple control of locomotives. He says, "Mr. Lamme's silence as to the multiple control of locomotives of the Westinghouse type is certainly significant. My system of multiple locomotive control, which I described and patented some five years ago, consists essentially of four small wires along the train and a field rheostat on each locomotive. Here is an advantage in weight, reliability, simplicity, first cost, and efficiency, in my system for heavy traction, which more than compensates for all objections that can be raised against the motor generator." In the course of his lengthy letter Mr. Ward Leonard takes up the subjects of division of load, frequency, recuperation, and weight of equipment, and in each instance advances the argument for his system compared with others in the field, but he seems to us to get at the heart of the controversy in one of his concluding paragraphs in which we are with him entirely. He states that "fortunately there are at present unmistakable signs of the dawn of a brilliant day in electric railway engineering, for the steam railways are beginning to employ electrical engineers who owe nothing to and care nothing for the electrical engineering and patent trust. *Mere manufacturers* (the italics are ours) will not much longer control the electric railway engineering in this country, for trunk line electric traction involves interests so large and so varied as to insure, in the immediate future, competent engineers, who will tell manufacturers what they shall make for them, and will not say 'What have you in stock?'"

Mr. Ward Leonard then challenges Mr. Lamme to produce performance figures of his New Haven locomotive to place beside those obtained from a year's operation of his system by the Oerlikon Co. If this gage be taken up we shall have some valuable figures to publish in an early issue.

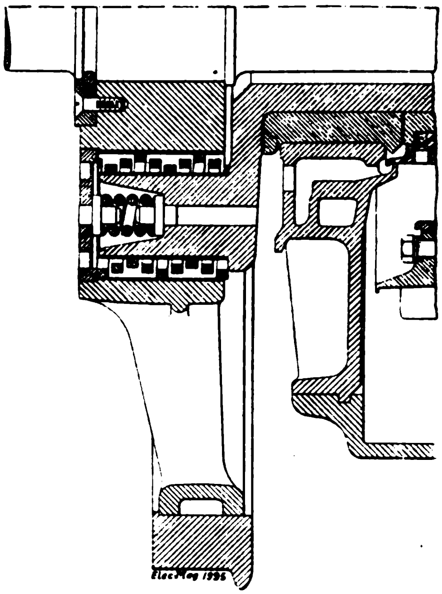

FIG. 2. SECTION THROUGH PORTION OF WHEEL AND AXLE, SHOWING METHOD OF SUSPENSION OF MOTOR AND ARMATURE.

Direct-coupled One-phase Locomotive Motors.

Little or no reticence is being shown by the Westinghouse interests in regard to the constructional details of the New Haven one-phase locomotives to which we referred in our last issue. American technical journals, during the past few weeks, have published further particulars of these interesting machines to those given by Mr. Lamme in his Railroad Club paper. The method of mounting and coupling the motor is particularly ingenious, and is the subject of a separate patent. Special precautions are taken to ensure that both gravitational and torsional forces of the armature shall be transmitted through elastic media, and in taking these a carefully designed spring suspension and coupling were used. The difficulties with a gearless one-phase motor are greater than those presented by direct-current machines, because the air gap must be maintained constant. The mounting of the motor-field system is shown in Fig. 1, which depicts the complete motor with its driving-wheels. Reference to Fig. 2 will explain the method of ensuring the constancy of the air gap. A section is taken through a portion of the wheel, axle, armature, and field frame, and it will be seen that the last two are carried on a quill through which the axle passes, leaving ample clearance. The quill is fitted with the driving pins (shown in Fig. 3) and special suspension and torsional springs. The field frame is clamped to two discs, one at each end of the armature, which bear on the quill close to the hub and

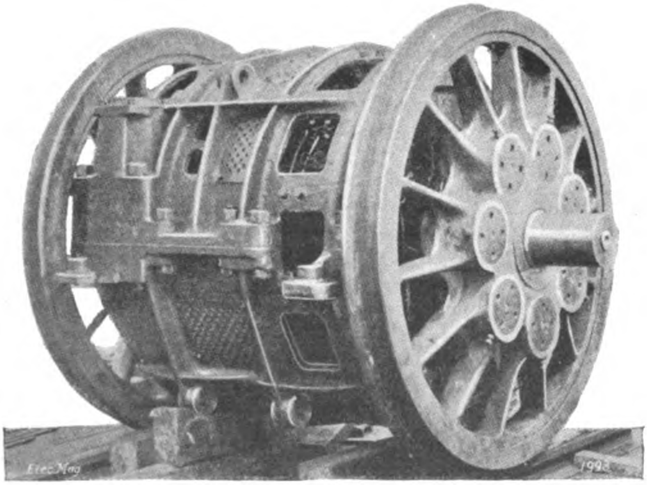

FIG. 1. LARGE ONE-PHASE RAILWAY MOTOR MOUNTED BETWEEN DRIVING WHEELS.

allow of it (the quill) turning by reason of special split bronze bearings. The field system is thus independent of the axles, and it is also separately hung in regard to the truck. A distinct steel frame is provided, coupling the two motor frames on the truck and pivoted from the journal boxes of each locomotive axle. This independence of motor frame and truck places the driving-motors beyond the influence of the swinging of the locomotive truck, and further it is possible for only a cushioned blow from the motors to reach the rails.

In connection with the pulsating torque of the single-phase series motor it is especially noteworthy that, although the torque of the machine pulsates at twice the circuit frequency, and the electrical torque varies from its maximum value to zero, and even assuming a reverse value if the field flux is not in time-phase with the armature current, such condition does not exist with reference to the mechanical torque which reaches the drivers. The pulsation in the value of this latter torque depends upon the inertia of the matter, which may be moved by the electrical torque before the mechanical torque produces motion, and upon the elasticity of the medium which permits the movement. Thus with the locomotive in question, when the drivers are stationary, each mechanical position which the field and armature structures of the motor assume causes to be transmitted through the springs to the drivers a certain definite value of mechanical torque. In order for the mechanical torque to reach zero fifty times per second, it would be necessary for the field and armature structures to be returned by the springs to the zero torque an equal number of times in this period. The final result is that, unless the inertia of the moving mass and the elasticity of the springs happen to be adjusted for vibrational resonance at the circuit frequency, the armature and field structures will vibrate through very narrow limits, and the torque, which reaches the drivers, and which fluctuates in unison with the electrical torque, will be almost constant at a value equal to about one-half of the maximum electrical torque.

Observations have shown that the mechanical torque exerted by the locomotive drivers varies only slightly, although the torque of the motors, as found under brake tests, fluctuates through a considerable range. A fluctuating mechanical torque would be undesirable under conditions where the motors are required to exert at starting a torque sufficient to slip the drivers. In this case the torque available for acceleration would bear to that which could be obtained with direct-current motors the ratio of the average to the maximum torque, viz.: 50 per cent. for rigid suspension, and values up almost to 100 per cent. for spring suspensions. In the New Haven locomotive the necessary and unavoidable weight of the equipment is so much larger than that corresponding to the product of the required draw-bar pull and the coefficient of tractional friction that the slipping of the drivers is almost impossible.

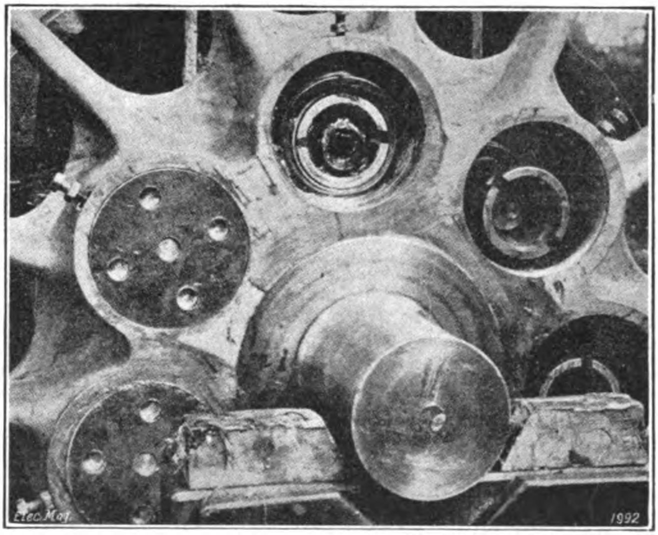

Fig. 3. Driving Pins and Springs in Pockets of Driving Wheel.

British Electrical Enterprise.

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Electric Tramways and Motor 'Buses.

THE time is evidently approaching at which the relative merits of the electric tram and the motor 'bus can be arrived at without undue bias in favour of either. At its first appearance the motor 'bus was heralded as the St. George of a new transport to the Dragon of the old, and the most extravagant stories are now prevalent in consequence; but so does an inspired lay Press assist, doubtless with good intent, in the launching of ventures which level-headed engineering would condemn out of hand. In our last issue we published figures from a paper, comparing these so-called transport rivals, by Mr. E. Manville, and these indicated that for the conditions postulated the electric tram was superior. The subject is one that cannot fail to interest our readers, so we purpose presenting the most important references of the technical Press to the paper and subsequent discussion.

In nearly three columns of editorial comment in its leader section the *Electrician* goes closely into the arguments *pro* and *con.* Attention is drawn to a serious omission from the figures of the motor 'bus devotees, and reference is made to this in the following terms:—"The omnibus advocates leave out of their cost estimates the capital and maintenance expenditure upon the roads and streets which they use, but the tramways are charged, not only with such expenses upon their own proper road, the rails, but also maintain a paved surface used by other traffic, and pay rates which are partly devoted to general road maintenance. In considering the question, a local authority must, therefore, ascertain the whole cost of a motor 'bus service, and the item of road maintenance must be included, just as it is included in tramway accounts, but the rates paid by tramways should be deducted from the tramway working expenses, for such payments are merely extra rates or tolls levied upon tramway passengers for the benefit of the general body of ratepayers by a legal anomaly."

The same journal concludes an excellently worded argument by stating that "if those newspapers which have so eloquently preached the imminent supersession of the tramway could summarize the facts presented, and put before their readers the views of the present automobile men as prominently as they have announced the coming end of the tramway, and have advertised the prospectuses of too many motor 'bus companies, they might yet save the money of many innocent investors, and relieve the motor manufacturers from the uncomfortable pressure which they now suffer. In conclusion, we would repeat that the electric tramway holds its own as the most economical, convenient, and generally useful means of carrying a large passenger traffic along definite routes. Prophecy in these matters is rash, but we do not think we incur any serious risk in predicting that at least our existing tramways in populous places will have ample opportunity to wear out before they are superseded."

The *Automotor Journal* has always championed the cause of the motor 'bus, though we will admit with none of that tall talk common to the lay Press.

"The struggle, or the friendly rivalry, between the electric tram and the motor 'bus which is just beginning, constitutes one of the most important locomotion problems that at present confront us. On the whole, the general consensus of opinion is that, at any rate for a long time to come, both the motor 'bus and the electric tram are bound to have their own individual spheres of influence. As examples in point, the West End traffic, where the motor 'bus is always likely to be the favourite, and the East End, where the conditions of population are such that there is nothing to deprive the tram of the popularity which it undoubtedly possesses, were, as regards London, specially mentioned. At present, too, there seem to be grounds for the belief that where enormous numbers of travellers have to be 'shifted' daily, and where other wheeled traffic is not congested, the motor 'bus is not at all likely to compete successfully with the electric tram. . . ."

We think it is yet early for any definite pronouncement on this subject, as such figures as are put forward by the motor 'bus advocates are estimated only. It is to be hoped, however, that when they are in possession of data based on their running and maintenance experiences, they will make a faithful presentation of the same, and do nothing which may reflect on the integrity of the industry, or prejudice its development in the immediate future. The temptation to exaggerate is very great when one has good figures on the one hand and a trusting public on the other.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Central Station Auxiliaries.

THE auxiliaries in a central station are more often than not seriously neglected by the designer of the plant; consequently the engineer who ultimately comes to run it finds it difficult to attain a high standard of operating efficiency. By auxiliaries we mean the coal and ash handling plant, the economizers, and the condensers. The second-named are either omitted or installed too large, but they do not meet with the treatment served out to the other two important sections of the station.

With the erection of larger power plants, greater attention is being paid to the auxiliaries and the frequently elaborate design of these is the envy of engineers in charge of stations from which they are conspicuously absent. Certain it is that a station above 5000kw. is now regarded as incomplete without coal and ash handling plant, while condensers are considered absolutely essential.

In the light of these opening remarks, some interest attaches to the coal-handling plant of a large American power-station and also of a special feature of the condensing plant. The station in question is that of the Pennsylvania Railroad Company on Long Island, erected for the supply of energy to an extensive railway system in process of electrification. Fig. 1 is a section through the engine and boiler houses and gives an excellent idea of the lay-out of the station. The boilers are in two tiers with coal hopper above, and close under the roof will be noticed the waggon-way for the supply of coal. The location of the condensing plant will also be noticeable and the tunnels for supply and discharge of condenser water. Fig. 2 depicts the exterior of the station, the river and the coal and ash towers with over head cableway between. Coal can be delivered by rail or water, but the latter is cheaper, so the bulk of the fuel is handled in barges. The coal-tower, though primarily intended to deal with barge traffic, can also be modified to cope with rail-borne coal. The plant comprises a coal-hoisting tower, on the right of Fig. 2, a cable railroad carried by a steel bridge and an ash-tower, to the left of the same illustration adjoining the end of the boiler-house. The bridge is 107ft. above the dock, and about two-thirds the height of the coal-tower, which is 170ft. high. The hoisting engine is placed some 25ft. above the water in a special structure, which, while commanding a good view of the coaling operations, is not too high to cause stoppage during foggy weather through the obscuring of the view from the control platform. Frequently the man at the engine is placed so high above the unloading point that in a fog he is useless, as he cannot see what signals are made to him. Coal is hoisted in a bucket "biting" two tons at a time, and a separate engine actuates the "bite" through an independent rope. The bucket is counterweighted so that when being lowered its speed cannot exceed 1000ft. per minute. A substantial trolley supports the bucket on a rigid boom built up of steel trusses projecting 43ft. from the tower at a height of 163ft. above the dock. The bucket can complete its trip—that is load, hoist, run in over hopper, dump, run out, and descend again to the barge—in 45

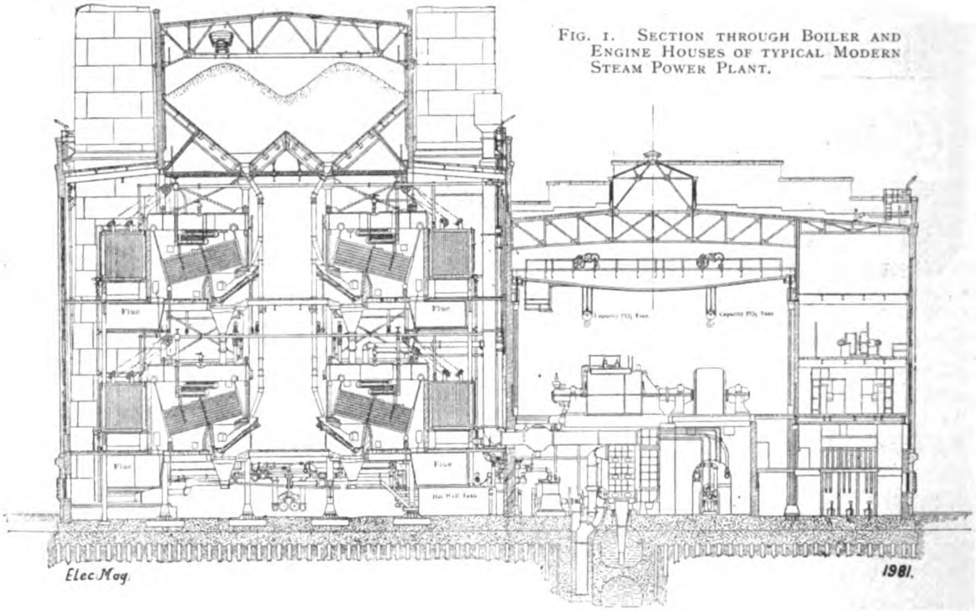


FIG. 1. SECTION THROUGH BOILER AND ENGINE HOUSES OF TYPICAL MODERN STEAM POWER PLANT.

seconds. It must be evident from such a record in expedition that coal-handling plant is worth the outlay in the time saved.

Referring again to Fig. 2 it will be noticed that under the hoisting boom, on a level with the railway, is an enclosed structure. This is of corrugated copper sheathing and forms a two-storey house for the crushing and weighing plant, the roof of the former being the receiving hopper. The bridge connecting the tower with the boiler-house is 500ft. long and is supported on three piers, the last nearest the station being built in to form the ash-tower. The raising of the coal in one stage to the boiler-hopper level greatly reduces the amount of handling and also prevents the excessive pulverising common to a large number of elevators and conveyors.

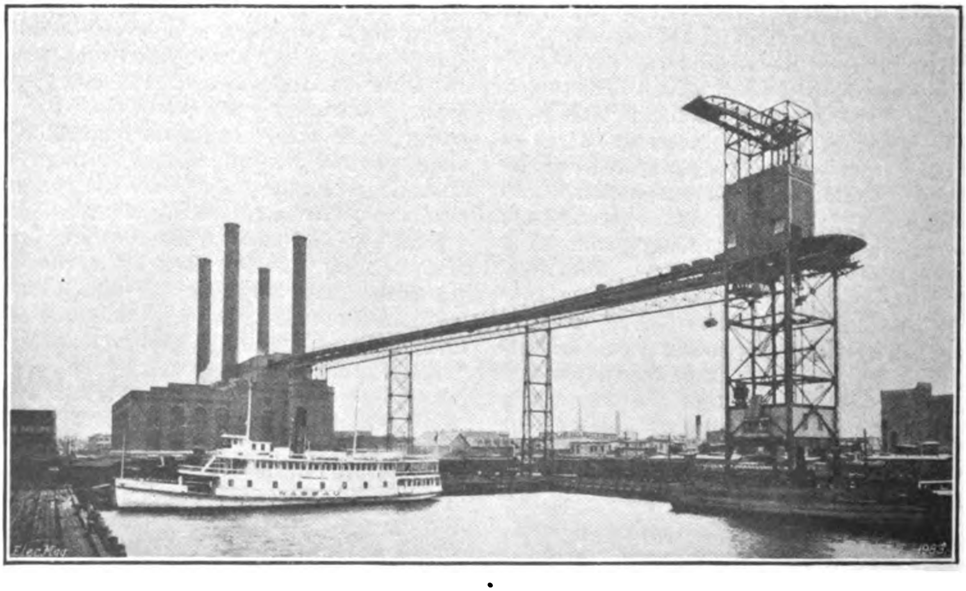
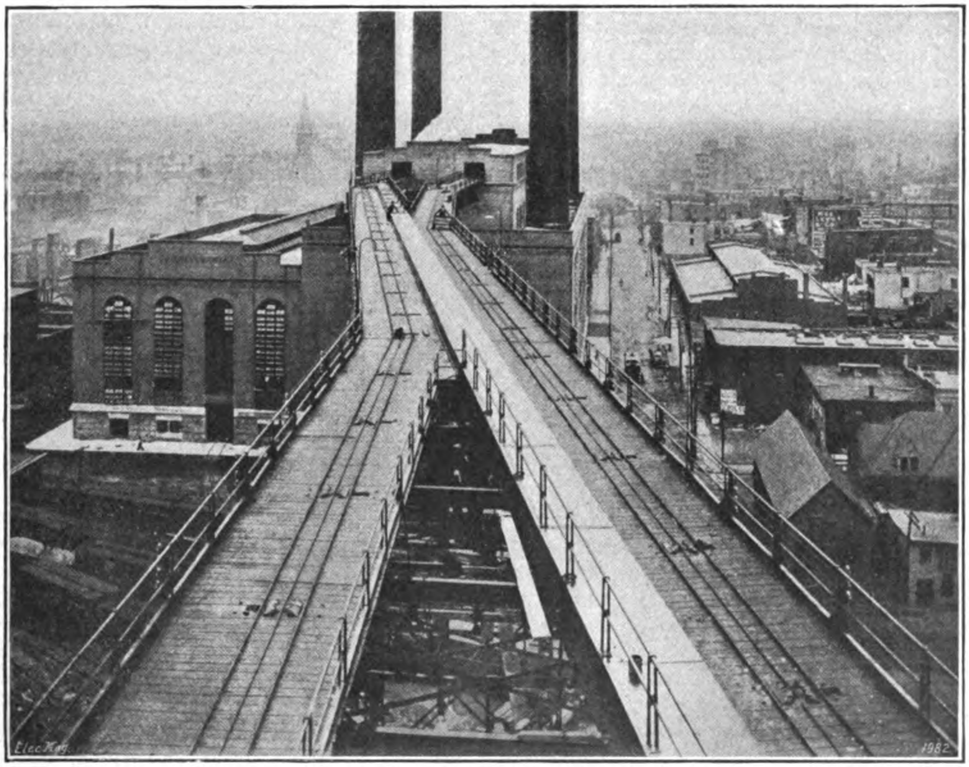


FIG. 2. GENERAL VIEW OF COAL TOWER, WAGGON WAY, ASH TOWER, AND POWER HOUSE.

The cable railway has a capacity of 150 tons per hour when actuating 29 cars of two tons each at 180ft. per minute round a track loop about 2500ft. long. The cars dump their load without releasing the cable and return automatically to the loading hopper. The estimated costs, including labour supplies and fixed charges, per ton of coal are about 4½d. per ton on the basis of 480 tons handled per day. Singularly enough all the power is furnished by steam engines, supplied by lengths of piping from the main boiler-house.



View, looking towards the Power House, of Waggon Way and Cable Tracks.

The condenser equipment proper of this station calls for no special comment, but an accessory to it is of exceptional interest. It comprises a special booster to prevent electrolytic action in the condenser tubes. Salt water is used for circulating, and considerable potential differences were found to exist between different points around the station, so that precautions of some kind were considered essential to safeguard the condenser tubes. The connections to the adjacent water mains, for the boiler feed, are through two 14in. pipes, and the electric tram tracks adjoin the city mains in all parts, so these pipes tend to conduct stray currents into the station. The first precaution taken is to provide a shunt circuit for these currents between the incoming water pipes and the condenser flume. Insulated lengths of pipe are inserted at each end and connected by a stout insulated cable, which is supposed to conduct stray currents to the harbour direct instead of through the condensers. A booster is employed as a second precaution to neutralize any currents which may pass the insulated joints. The positive pole is connected to the heavy cable and the negative to seven different points on each condenser, with an adjustable resistance in each circuit. The superimposed booster voltage can be exactly set to counterbalance the natural galvanic electromotive forces due to the brass tubes, the iron shell and the circulating water, together with the stray electromotive forces from outside. With the destructive potentials so counterbalanced the condenser is in a neutral electric state which effectively prevents corrosion and pitting of the condenser tubes and sheets. A differential voltmeter is provided for each seven rheostats so that the men in charge can adjust the state of the circuits to a nicety. These precautionary measures have so far given complete satisfaction, and the arrangement may well commend itself to engineers troubled in the manner mentioned.

The Field of Direct-Current Service.

In an article in *Cassier's Magazine* Mr. H. L. Abbott presents the advantages of a direct-current electric supply, taking the stand that there are situations where the alternating current is not so convenient. The enthusiasm which almost always accompanies the successful commercial development of new apparatus makes it easy at times to overlook the solid and tried advantages of established practice. These remarks apply particularly to the present time, when the alternating-current motor is making such phenomenal conquests in the great field of railway transportation. But it is well to realize what a strong grip direct current still has on many kinds of service and to remember that an engineer may sometimes prescribe a continuous-current system without being hopelessly out of date and retain one in commission without falling from grace. The great bulk of central-station business in the congested districts of large cities is handled by direct-current equipment. Even in those cases where the distance of transmission has warranted the installation of high-tension, alternating-current lines feeding sub-stations which, in turn, have become local centres of distribution, the direct supply of energy to the consumer is largely accomplished by continuous-current circuits. It is an open question whether there is any real economy in the use of alternating-current equipment in the business districts of large cities for general power and lighting work, although, of course, many special cases arise where the transformer or the induction motor is better adapted to the work in hand. From the standpoint of a power-station designer and operator it is a great advantage to have to generate only one kind of current, but in the commercial operation of a great distribution system a number of other considerations enter besides the first cost, operating efficiency and convenience of the power plant. One of the most obvious reasons for the retention of the direct-current service in the larger cities is the enormous investment which at present exists in this system. Hundreds of thousands of horse-power in motors and almost countless arc and incandescent lamps are owned by the electricity supply companies or their customers in addition to the generating machinery and the distributing plant. In some of the smaller cities the managers of the electricity supply companies have reached a point where no direct current is sold outside of their stations, but in such cases generally the original investment in generators and underground lines has not been great. An important point in favour of the direct-current service is the relation existing between it and the storage battery. Aside from its use in parallel with exciters, the battery has little application in a pure alternating-current system. The regulation in voltage possible from the central generating plant or sub-station in a system which is characterised by direct-current distribution is probably much better than the alternating plant can provide on the whole. Although the number of sub-stations required can often be reduced when alternating-current is substituted for direct-current distribution, it is out of the question to do away entirely with sub-stations and to obtain first-class regulation at a distance from centres. The substitution of transformers for rotaries or motor-generators at distributing points means a notable gain in operating efficiency and a decrease in the power-house capacity required to deliver a given amount of current at the distribution centre, provided, of course, switches are installed for disconnecting the high-tension side of the transformer when they are not in use, thus saving the core losses. A striking limitation of the alternating-current system of distribution is found in the difficulty of giving as good elevator service with it as with direct current. To the central station the elevator problem is an exceedingly important one, for in the large city the central station manager cannot drive out the isolated plant unless he can guarantee to supply the best quality of elevator service as well as light and power generally. The whole question of extending alternating-current urban distribution hinges more upon the development of the single-phase motor than upon any other factor, but the question of retaining the existing direct-current distribution systems is a much broader one.

LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

The Need for the Illuminating Engineer.

By LEON GASTER.

(Concluded from p. 250.)

FOR the use of oil, improvements are constantly being made in the manufacture of lamps ; in particular with the high c.p. oil vapour lamps of the Kitson, Lucas, Lux, Millennium, &c., types, or of the alcohol vapour type. The acetylene gas light has obtained considerable vogue in the last few years, and so have many more illuminants.

In examining the figures given by Mr. Marks in his Presidential address, one finds that the annual expenditure for lighting purposes in the United States is roughly estimated to be about forty million pounds. The expenditure in this country, so far as I can ascertain, may be estimated roughly to be classified as follows :—Between twenty and twenty-two million pounds per annum for gas lighting, seven to eight millions for electric, and over five millions for oil, amounting in total to between thirty and thirty-five million pounds, of which, if only five per cent. were annually saved, over one and a half million pounds could be turned to better advantage, giving better illumination to the public, and providing employment for a large number of engineers who would willingly specialise for this particular new branch of the art.

From what has been said before, I would venture to suggest that the time is ripe to inaugurate a similar illuminating society in this country. The merits of the different illuminants could then be properly studied and the useful application be defined for each of them. An "Institution" could afterwards be created, in which all the different illuminants would have a fair chance of being shown under the best conditions and their relative merits properly gauged. A permanent exhibition would thereby be formed which, to my mind, would be of great benefit to consumers, and of exceedingly important educational value to the future illuminating engineer. For the present he has not enough opportunity of being educated to become such an expert, and this will then be afforded to him through lectures by the best professors and known experts, familiar with the different illuminants. He would then know not only one of the illuminants, as is mostly the case at present, but would become perfectly conversant with the merits and faults of all, so that he could conscientiously and properly advise his clients as to the actual merits of the different illuminants for the different purposes in view.

Without wishing to dictate any course of action, I should think that a powerful body such as the London County Council, for example, may in time see its way to grant a fund for the building and maintenance of such a permanent home for the different illuminants. The many local authorities which are owners of gas and electric plant will be only too glad to know how they can reasonably utilize the different lighting commodities to the best advantage of the ratepayers. We have an example in the street lighting question, in which the differences of opinion are so great that one feels the necessity of some central authority to advise on these matters, and to settle what is best adaptable for the different kinds of streets in towns. London may reasonably become the leader.

The technical side, however, viz., the close investigation of the relative value of the different illuminants as regards c.p. given out, the consumption of energy, electric, gas, &c., and other such questions, can be conveniently undertaken and settled by the National Physical Laboratory, the work being done for the benefit of the public. The practical application of the different illuminants could then be constantly demonstrated at the future illuminating Institution which I am picturing, conducted by properly qualified and trained illuminating engineers. A Museum might advantageously be established, attached to the Institution, in which the progress and development of the different systems of illumination could be kept on record. Naturally, I should also like to see there a specially well equipped library for reference.

It is anticipated that in this Illuminating Engineering Society no antagonistic feeling should be created between different illuminating engineers; on the contrary, each should contribute to bring apparently conflicting interests closer together, expounding and exchanging views on the relative merits of the different illuminants.

The formation of an Illuminating Engineering Society ought to receive a hearty support from the council of the gas and electric institutions, and I should think the newly formed British Science Guild, whose object is to try and convince the people by means of publications and meetings of the necessity of applying the methods of science to all branches of human endeavour. For promoting and extending the application of scientific principles to industrial and general purposes, and furthering the progress and increasing the welfare of the Empire, it should take this opportunity and utilise its great influence in encouraging the formation of this society.

From the encouraging remarks made in your last Editorial, and from similar remarks I read in other leading journals, the sympathy for the formation of such a society is so far secured.

In the paper read by me before the Society of Arts recently, on the Progress in Electric Lighting, I suggested that there is a wide field open for the illuminating engineer, and I shall be glad to receive, at my address, 32, Victoria Street, S.W., the names of any engineers who have had particular experience with general lighting, and are willing to join me in the formation of an Illuminating Engineering Society in this country.

I have particularly refrained from giving any data or mentioning names of consumers or of places where the advantages derived from the advice of the illuminating engineer have been proved beyond doubt, as most of the lighting engineers can bear me out that, in many cases where they had a free hand and dealt with reasonable clients, great economies and satisfaction have been derived from the proper application of scientific principles of artificial illumination.

The growing recognition of illuminating engineering as an art is indicated by the recent establishment at the American General Electric Company's works of a special department of illuminating engineering in charge of an expert. Amongst other purposes of this department will be the co-operation with central station engineers in submitting attractive lighting plans to prospective customers.

The great importance attached in the States to this illuminating question is further exemplified by the starting of a new monthly journal entitled the *Illuminating Engineer*, which is exclusively devoted to the advancing of the practical knowledge of the science and art of illumination. The first number appeared in March, and the journal is edited by Mr. E. L. Elliott, of New York. The series of interesting articles in the first number clearly proves the necessity which exists for such a special journal dealing with the different illuminants from the impartial student's point of view. Although a short account is given in this first issue of the meetings of the Illuminating Engineering Society, of New York, I understand that the proceedings of the society will be separately published at an early date. The successful formation of the New York Society has contributed to induce the Chicago engineers to start shortly with a branch in that city.

The scope of the Illuminating Engineering Society is well indicated in the series of selected subjects on which papers are to be read before the New York Society, and from the deliberation of which subjects great advantage could be derived by the engineers and the public generally. It is not intended in this article to fully describe the constitution or by-laws of such a society, as this will have to be considered afterwards. My object is to stimulate interest in the formation of such a society in this country, as I strongly believe it would be of inestimable value to the lighting industries.

An Example of House Lighting Design.

By J. R. CRAVATH and V. R. LANSINGH.

THE planning of the illumination for a house or any building should precede that of planning the wiring, because illumination is the ultimate purpose for which the wiring is to be installed. As illumination is the primary object desired, we should work back from the desired illumination to the outlets, installation of wires and machinery and not *vice versa*, as is too frequently done. The accompanying plans shown in Figs. 1, 2, and 3 are of a house recently built in Pasadena, Cal., where the owner desired to obtain excellent illumination with a minimum operating cost. It was recognized at the outset that the first cost of installing the lighting system was small when compared with the running or operating cost from year to year, and, therefore, an effort was made to reduce operating expenses by securing a maximum efficiency of illumination rather than to cut down the cost of installation in general.

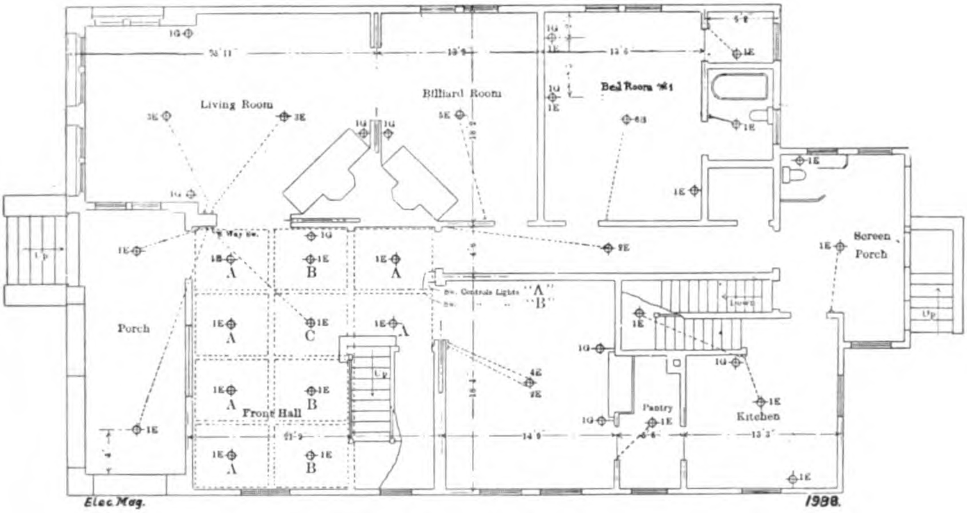


FIG. 1. ARRANGEMENT OF LIGHTING POSITIONS ON GROUND FLOOR.

Globes and reflectors were used in the majority of places for directing light in the particular directions desired in each case, and so combining economy with pleasing appearance. The specifications for the wiring are outside the province of this article. Although electric lighting is depended upon almost entirely in this house, a few gas jets have been provided for use should the electric service be temporarily interrupted.

The location of fixtures is marked on the plans by the usual cross and circle; 1E marked opposite a fixture on the plans indicates one electric socket, 2E two electric sockets, and so on. Gas tips are indicated by the mark 1G opposite the fixture. Push flush switches are indicated by straight heavy lines with dotted lines leading to the lights they control whenever feasible. Snap switches are indicated by half-circles. There is need for a standard system of symbols to indicate these matters, but as this subject has never been extensively discussed, the authors will not attempt to propose such a set here, as that is a matter which might well be taken up by the Illuminating Engineering Society.

In planning the location of fixtures, especially that of wall brackets in bedrooms, it is desirable to have some means of quickly showing the probable location of furniture or of trying the furniture in different locations. For doing this either in conference with the owner of the house, or even if the entire matter is left to the illuminating engineer, a plan adopted by Mr. J. Kermode, of the Cleveland Electric Illuminating Company, is to be recommended. Miniature furniture carved out of wood to the same scale as the architect's plans is provided, so that beds, dressers, chairs, and tables can be ranged in the room under consideration just as they would probably be after the house is finished. In this way both the engineer and the owner can see what is wanted much more quickly than by attempting to picture the situation mentally, and measure up the available spaces with a rule. The reasons for adopting the plans as shown can best be seen by considering each room briefly.

Porch.—One light was placed in front of the door to light the doorway and steps. Inasmuch as the porch would probably be used in the evening, another light was desirable and placed at the other end. These lights are controlled by separate switches, so that only one need be turned on. A ball globe with directing prisms was specified because of its handsome appearance and its ability to throw the light strongly downward, although reflectors would have given a greater amount of downward light. In case it is desired to read on the porch, 16c.p. lamps are necessary, otherwise 8c.p. or 4c.p. would suffice.

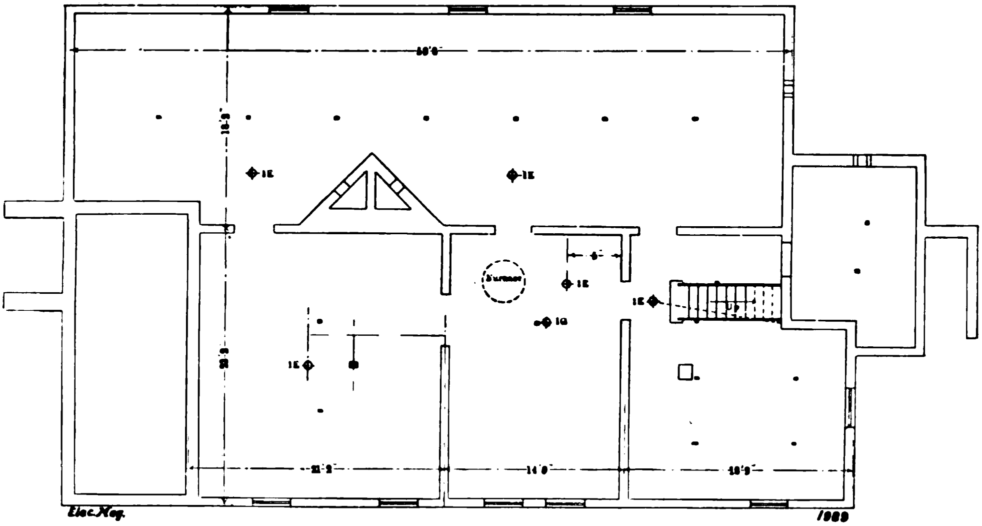


Fig. 2. The Disposition of Lights in the Basement.

Front Hall.—The lights in the front hall or reception room were placed on three separate circuits. One light, which can be used as a night light, is controlled both from a three-way switch placed close to the entrance and by another three-way switch upstairs. Lights A were placed on another switch and lights B on a third switch. With these three switches it is therefore possible to get a number of combinations of light, and the arrangement is such as not to interfere with the symmetry and artistic effect of the lighting when they are not all turned on. The gas bracket in this hall has a globe which will throw the maximum light side-wise so as to light as much as possible the entire hall.

Living room. — As this room was large, two chandeliers were used, equipped with cut-glass prism balls hanging straight down so as to throw the maximum light on a table or on the book of a person sitting underneath.

Billiard-room. — In order to provide, first, uniform table illumination of sufficient strength; second, avoid shadows which are unavoidable when the light is concentrated over the middle of the third table; third, keep the light as much as possible out of the eyes of the players to prevent blinding; fourth, provide sufficient general light in the room to make it possible to count the string easily, and, fifth, keep the glassware out of the way, where it will not be easily broken.

The bed of a billiard-table is generally 31in. above the floor, and if the lights are from 7ft. to 4ft. above the bed of the table the results will be satisfactory. Generally speaking, the lights (given an even distribution of illumination over an area 45deg. each way from the vertical) should be for a 5ft. × 10ft. table 6½ft. apart lengthwise, and 3ft. apart sidewise. For a 4½ft. × 9ft. table they should be 6ft. lengthwise, and 33in. sidewise. In both cases the sockets should hang 7ft. from the floor, which would bring the reflector about 4½ft. from the bed of the table.

Bedroom.—The bedrooms were all treated practically alike. The general illumination is given by a three-light chandelier placed in the centre of the ceiling, 8ft. above the floor. The lights are pointed downward and provided with a rather concentrated form of reflector with 8c.p. lamps, which gives a good light throughout the room and provides sufficient concentrated illumination for writing and reading directly underneath. With very dark walls this candle-power might have to be increased somewhat. With light walls it is ample. A bracket is provided on each side of the dresser, the brackets being placed 5ft. apart and equipped with glassware designed to throw the light on a person standing in front of the mirror. With the form of chandelier used (which is close to the ceiling), sufficient light is thrown on the top of a person's head to light the hair and make unnecessary a bracket or pendant light over the top of the dresser, otherwise such a light would be advisable. Over the head of the bed is provided a 4c.p. lamp in a concentrated reflector with a chain socket to provide for reading in bed, and for a light of easy access for one awakening in the night. Gas is provided in each room simply for use in case of breakdown to the electric service, which unfortunately is all too common in that city, owing to the tremendous expansion of the business.

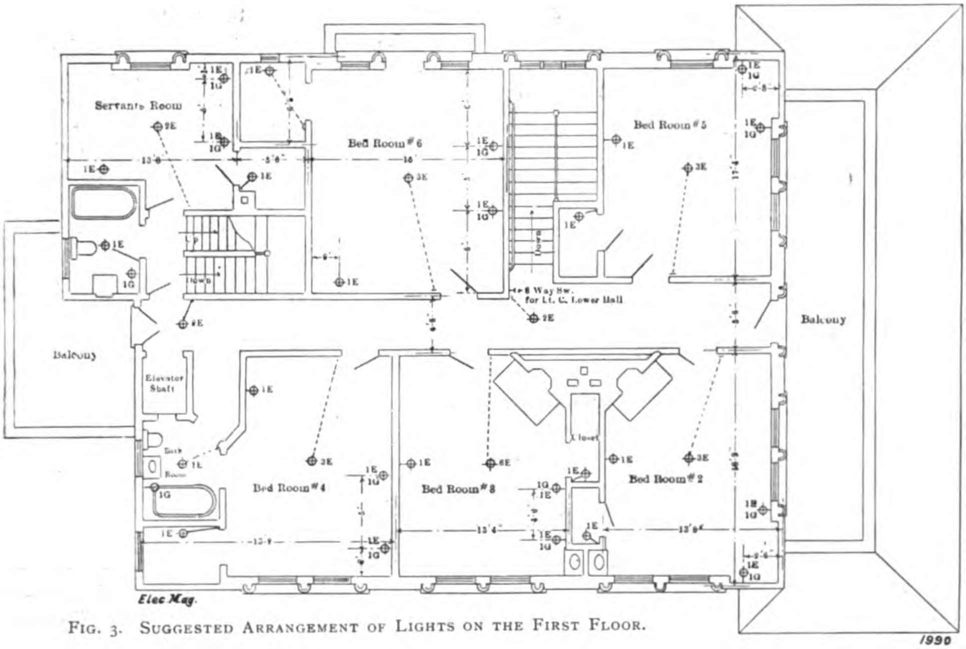


FIG. 3. SUGGESTED ARRANGEMENT OF LIGHTS ON THE FIRST FLOOR.

Centre Halls. — The centre halls were lighted by two-light chandeliers with lamps pointing lengthwise of the hall, and provided with concentrating reflectors at such an angle as to light the ends of the hall.

Bathrooms.—A 4c.p. lamp placed in a prismatic reflector upon the ceiling is all that is necessary unless the room is used for shaving. In the latter case two 4c.p. frosted lamps placed one on each side of the mirror are sufficient.

Kitchen.—One lamp was placed in the centre of the ceiling of the kitchen for the general lighting of the room. The reflector chosen, No. 7381, lights evenly the entire lower portion of the room. A lamp was placed in a bracket over the sink to give a strong light where most needed in dish washing.

Dining-room.—The principal lighting of the table is by an art-glass dome in which is a lamp pointing straight down and equipped with a prismatic reflector of a type which will light the whole top of the table evenly, and allow some to go through the art-glass for decorative purposes.

It is of interest to note the candle-power of the lamps actually used after a study of the lighting effects had been made upon the completion of the house. In this house the changes made in the schedule were as follows :—

In the basement and attic all the lamps were changed to 8c.p., for general illumination, special illumination being taken care of by an extension plug and lamp on portable cord. As the porch is not used for reading, the lamps were changed from 16c.p. to 8c.p. In the living room, a special form of fixture being adopted, the number of lamps of 16c.p. was increased from 6 to 8. In the halls, as the walls and ceilings were light, 4c.p. instead of 8c.p. lamps proved ample. In the kitchen the candle-power of the lamp over the sink was increased from 4c.p. to 8c.p.—Abstracted from *Electrical World.*

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Long-flame Arc Lamps.

ELECTRICAL engineers generally are interested in the development of the flame arc lamp and consequently are in need of more detailed information as to their operation and efficiency. It is with this pattern lamp that they hope to beat incandescent gas from the streets and to maintain the position they now hold with ordinary arcs for shop and yard lighting. Mr. Leonard Andrews, in an admirable paper read before the Institution recently, collects together a quantity of very useful matter on the subject of flame arc lamps and this will bear careful detailed perusal by those interested in the subject. We have not space at disposal to go fully into his treatment of the matter, but we abstract from the paper a few of the concluding paragraphs, which are certainly interesting.

He says : " It is interesting to note that arc lamp designers have during recent years paid very much more attention to general effect and distribution of light. There is no doubt that for effective lighting the globe should have the appearance of being *full* of light. The popularity that has recently been attained by several types of enclosed arc lamps is undoubtedly in a great measure due to the use of small globes, and whilst the efficiency expressed in the mean hemispherical candle-power per watt is considerably lower than that of the large globe open-type arc, the efficiency expressed in the 'satisfaction to the general public per watt' is considerably greater. The long-flame arc is particularly well adapted for use with small globes, and all flame lamps, whether of the chemical-carbon type or of the high-voltage pure-carbon type, always appear to give a good globeful of light. This effect is also in a great measure due to the absence of shadows, resulting from the use of inclined carbons.

" It must be remembered that the general public do not judge of the efficiency of any lighting system by taking photometric tests. It would probably be much better for the electrical industry if they did. Their usual method of judging a light is, first, to look at the source of light, to satisfy themselves that there is a large area of light-giving surface, and secondly to examine the ground directly below the lamp they are judging. The engineer, however, recognises that it is of even greater importance to know what is the minimum illumination midway between lights than it is to know the maximum illumination below the arc.

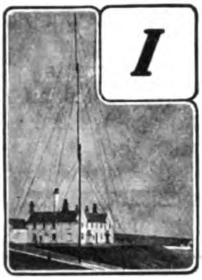
" It is well known that at least 40 per cent. of the light emitted by an arc lamp is intercepted by the opalescent globe. This waste with ordinary arc lamps appears to be necessary, in the first place, to prevent the dazzling effect which would result from an unscreened arc fixed at a position which comes within the natural angle of sight, and in the second place to give a diffused light or the effect of a light emitted from a large surface. Dealing first with the screening effect necessary to prevent dazzling, this need not be considered if the source of light can be placed at such a height above the ground that it does not come within the natural angle of sight.

" Owing to the fact that with an ordinary arc the bulk of the light is emitted at angles of less than 60deg. below the horizontal it is necessary to place such lamps comparatively near the ground to get efficient results from them. This objection does not, however, apply to long-flame arc lamps in which the maximum light is directly below the arc. It appears, therefore, that for many purposes, such for instance as for lighting large buildings where the source of light can be placed 30ft. or 40ft. above ground, it is unnecessary to use densely obscured globes. It is suggested that for this purpose long-flame arc lamps should be used fitted with globes of which the lower half is unobscured."

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Cable Telephony.

By C. A. RANDALL.



It is claimed that voice-caused currents have their maximum energy at the transmitter, their action being graphically illustrated by lines, sharp or curved, showing a wide movement on both sides of an imaginary central line, which movements gradually decrease and finally appear as a continuous line, and it is argued that when this condition prevails no effect can be produced upon the telephone receiver, and that the limit of distance for speech transmission has been more than reached.

At this point I wish to state that I take exception to all of these theories, laws, and erroneous conclusions, and to suggest that possibly the laws governing telegraphic transmission cannot and do not apply to telephony; that there is no such thing or effect in telephony as the retardation of the sound-produced electric currents or impulses, as understood in telegraphy; and, further, that the telephonic impulses of a given energy will travel farther and more quickly, and with less attenuation, than corresponding telegraph currents, and also that they are less affected by the so-called static conditions of a cable, or that in their use upon a cable the same static conditions are not produced, whichever it may be (and probably the latter), and, therefore, that the strict application to telephony of the laws relating to telegraphy is a serious error.

In the transmission of messages by telegraph using the maximum current energy required and permissible over a given distance at a predetermined rate of speed, the recorded signals of dots and dashes run together by "tailing" or retardation, and the signals are unreadable, and the limit of telegraphic transmission under this condition is more than reached, because—and this is an important feature—in telegraphy an increase of current energy adds to the trouble instead of decreasing it, consequently the speed must be lessened or the line distance reduced.

In telephony, however, there is no apparent retardation in the transmission of telephonic impulses. This is proved by the fact that on any circuit over which it is possible to transmit speech, the words are complete and understandable, and not parts of words, no matter how rapidly they are spoken. The received messages may be exceedingly low and scarcely audible, even necessitating, possibly, the use of two receivers, nevertheless, no matter how low they may be, they can be understood until the resistance of distance is too great for the initial current employed at the transmitter.

One of the most common arguments set forth against cable telephony and in support of these theories of retardation and attenuation as the limiting factors in telephonic transmission, is the well-known fact that there is retardation or a "time limit" in the transmission and receipt of a telegraphic impulse, under some conditions, which does govern the speed or number of impulses sent in a given time and limits the distance. From this it is argued that the limit of distance in telephonic transmission over a cable must be materially reduced to that possible in telegraphy, because the telephone transmits so many more impulses for each word. This is absolutely an erroneous conclusion. As previously shown in reference to the 150-mile cable tests, the initial current determined the distance, irrespective of the number of impulses sent.

It is also a fact that a word of four, five, or more letters, is transmitted as quickly by telephone over any land line operated telegraphically direct, say 500 or 1000 miles, as a "Morse dot" transmitted by a manually operated key, and more quickly than a "dash."

This is an important fact, which seems to be overlooked by experts, but, if seriously considered, I do not think it will be questioned, as it can be readily proved. It makes no difference, therefore, whether there may be ten or ten thousand impulses per telephonic word, as they are all transmitted and the word they electrically represent is received commercially, and so perfectly that the voice or timbre of the speaker is known, and this is accomplished in the same time, or thereabouts, required to transmit and receive a "dot," the smallest fraction of a telegraphic letter.

This proves that the greater number of electrical impulses sent in speech transmission as compared to telegraph transmission in no way affect or limit the distance, and that so far as the electrical difficulties, effects, and conditions are concerned, on the basis of twenty-five words by telegraph per minute, at five letters per word and three impulses per letter, 375 impulses or "dots," we can transmit and receive 375 telephonic words per minute, or as rapidly as it is possible to speak distinctly into a telephone transmitter.

Further proofs of the fallacy of the present generally accepted theories have been furnished by tests over many circuits, including submarine cables from 60 to 400 miles in length, and over "artificial cables," among them being notably tests upon an artificial cable of the form constructed by Dr. Muirhead, of London. This form of cable is also used as a standard from which to construct submarine cables, it being claimed that results obtained thereon very positively indicate what results will be obtained on a submerged cable of equal length. It is very reasonable to calculate, therefore, that telephonic results over such artificial cable of a given length could be repeated over a similar submerged cable of same distance.

An artificial cable of this form having a resistance of 10,500 ohms and a capacity of about 570 microfarads, a K. R. of 6,000,000, equivalent to the K. R. of about 2500 nautical miles of a submarine cable, was arranged in a most approved way for telephonic tests. The telephone transmitter and receiver were so far separated from each other that the speech of the person at the transmitter could not be heard or confused with that transmitted through the cable to the receiver.

Over this cable "speech was transmitted and received in a thoroughly satisfactory manner, the articulation being clear and distinct with a full volume of sound," as reported by a well-known electrical engineer and expert in charge of the tests.

The results of these tests, and others referred to, and the illustrations and proofs given above, absolutely refute the arguments and theories against the transmission of speech over submarine cables because of the greater number of impulses or currents in telephony, the static effects of cables, and the retardation and attenuation of the transmitted impulses. Further than this, I know of no reason, having a metallic circuit, or "twisted pair" in a cable conductor, why the metallic circuit cannot be used for the transmission of speech, and the two sides of the circuit be used separately for telegraph work, simultaneously, as now practised upon long aerial lines, and I fully believe that this will be an accomplished fact in the near future.—Abstracted from *Telephony*.

Submarine Cables.

SUBMARINE cables are used in so few instances for the transmission of electrical energy for lighting and power purposes that practically all such cables are employed in telegraphy or telephony. When it is necessary to place conductors carrying heavy currents, such as are usual with lighting, &c., under water, the best cables for the purpose are those insulated with vulcanised india-rubber. Telegraph cables are almost universally insulated with gutta-percha; and cables made at the present time differ but little from those made during the early days of ocean telegraphy.

We have the copper conductor insulated with gutta-percha and then taped, protected by some fibrous material sheathed with an armouring of galvanised iron or steel wires, and finally finished off with a serving of yarn and tape. A deep-sea cable has an overall diameter of about one inch, while the end next the land, called the shore end, being protected with much heavier sheathing, is very much larger. "Shore-end" cable is some ten times heavier than that intended for deep water, the two being connected by what is termed the "intermediate."

In order to protect cables from the ravages of certain small marine animals, powdered silica is often mixed with the compound applied when serving the cable. As a further protection, a wrapping of brass tape is sometimes applied. The earlier cables were made in a very similar manner. A most interesting cable is that known as the "All-British Pacific." This was opened to the public in December, 1902. One part of this cable, from Fanning Island to Vancouver, is the greatest length yet laid in one piece; the distance between these two places is about four thousand geographical miles. This particular portion of the cable is made in rather a different manner to the remainder. The conductor consists of five strands, the four outers being closed round the central wire in such a manner that, while retaining the advantages of a strand, there is almost as much copper as in a solid conductor of equal diameter: thus, without much loss in conductivity, the capacity is considerably reduced.

Various forms of light—that is, of low specific gravity—cables have been employed, but apparently with little success. In order to keep down the weight, it has been suggested to protect cables with a layer of aluminium tape, but it is doubtful whether this would be satisfactory, considering the rapid action of chlorine on aluminium. With regard to "loading" telephone cables, this is a subject that, although of exceptional interest, is but imperfectly understood; the problem is how to more or less neutralise the effect due to capacity—how to bring the circuit towards that condition known in alternating current language as resonant. Not only is it necessary to transmit the sound with its amplitude not too much diminished, but the shape of the wave must also be kept approximately the same, or articulation will be imperfect. For long-distance telephony the old K.R. law has to be considerably modified. It does not appear feasible to use an alloy for the conductor, as alloys have a higher resistance than their constituents taken separately. If inductance coils are introduced, iron must be very carefully employed, or sounds are not clearly transmitted. Any such apparatus, although comparatively easy to attach to underground lines, would be a difficult matter with a cable lying at a depth of some three thousand fathoms. Air spacing, which, by the bye, does not appear to have been a success on some underground lines, can hardly be suggested for deep-sea cables. As well as transmitting the sound, some means are required to rectify the tendency of the sound wave to distortion: not only is it necessary to have amplitude, we also require clear articulation.—Mr. W. Smith before the Birmingham Electric Club.

An Opinion of Automatic Telephony.

We have heard much lately of the introduction into Great Britain of the automatic telephone and the most extravagant statements become prevalent regarding the improvements which will immediately follow its introduction. On the subject of economy the statements made are usually vague, though high hopes are entertained of a material saving over the manual. Mr. J. J. Carty in a paper recently read before the American Institute of Electrical Engineers on the subject of "Telephone Engineering" is not so sanguine of the automatic, and, although he does not condemn it, he has none too good an opinion of its possibilities. He says:—

"Upon a first view of the case the idea of using automatic machines and thus doing away with the labour of telephone operators appeals with much force, and the wonderful things which have been accomplished by American labour-saving inventions naturally come to mind. Among all of these projects for saving labour by automatic machines none seems more wonderful than the little machine which, when manipulated by the subscriber, will put him into communication with anyone out of thousands or tens of thousands of people scattered over a wide area. But in order that an automatic telephone switchboard should be properly called a labour-saving machine it must accomplish its work at an expense entailing less annual charges than would be required by the system which it attempts to displace. If it should be found that the annual charges of operating the automatic system were equal to or greater than the annual charges of operating the manual system, then the automatic system would not be a labour-saving one, and, considered from the standpoint of costs, would be a failure. Whatever merit it would have, in that event, must be looked for in some very superior results in the way of service. From this point of view I have considered the merits of the various automatic switchboard systems which have thus far been installed.

"I find that, taking into account all of the factors involved, and which go to make up the total annual charges which could properly be placed against the automatic switchboard system, on the one hand, and the manual system on the other hand, leaving out of account switchboards suitable for use only in small villages, and making comparison up to switchboards of 10,000 lines capacity, that the annual charges upon the automatic system are substantially greater than the annual charges upon a manual system operated on the common battery multiple plan. From the standpoint of costs, therefore, the automatic system fails when placed in competition with the common battery multiple-board operated manually."

"Having found that the automatic system could not successfully compete with the manual system in point of costs and annual charges, I made a careful investigation to determine whether the automatic system possessed any advantages of working over the manual system which might compensate for the extra annual charges which its use necessitates. For this purpose there were made about 7500 service tests on manual switchboards and automatic switchboards operating under practical conditions in different parts of the country. The results of these tests showed that the manual system possessed a most substantial greater degree of reliability than the automatic system. The difference in speed of connection between the two systems was so small as not to constitute a practical factor, the time elapsing between the start of the call and the answer of the called subscriber being in the case of the automatic system 19.9 seconds, and in the case of the manual system 21.7 seconds. These figures include the time taken by the subscriber to answer, and even this small difference of time was found to be due to the fact that the subscribers whose lines were tested answered somewhat quicker in the automatic system than in the manual system. It will be seen, therefore, from these tests that the automatic system possesses no practical service advantages over the manual system, and that it contains no elements sufficient to warrant any part of the extra cost which its use involves. A full consideration of the details of the comparison of these types of switchboards would lead me far beyond the limits assigned to this paper, and would only result in showing that the alleged advantage of doing away with the operators at the central office is imaginary and not real.

"All of the foregoing relates to switchboard systems smaller than 10,000 lines, no automatic switchboard of larger size having been installed.

"In order to determine whether for systems larger than 10,000 lines the automatic principle might be applicable, I made a study, assuming a system of 100,000 lines to be equipped with automatic switchboards, and compared this with a similar system equipped with common battery multiple switchboards operated on the manual basis. Here again the comparison is in favour of the manual board, both in point of annual charges and in respect to the service.

"In applying the automatic switchboard to this 100,000-line study, it was necessary to leave out of consideration a very large class of difficulties which crop out at every turn when the attempt is made to apply the automatic principle to the complex conditions which obtain in and around all large cities. Inasmuch, however, as the study showed that the automatic system is inferior to the manual system for a 100,000-line plant, it became unnecessary to take into account the large number of adverse factors which must be charged against the automatic plan of working. So important are these factors that it is safe to say that even if the annual charges on the automatic system were substantially less than those on the manual system, they would constitute such a serious objection to the automatic system as to bar its use.

"Throughout these investigations the importance of retaining at the central office operators to receive and attend to the subscribers' calls has been emphasized in so many important and unexpected ways that I have no hesitation in saying that no plan thus far employed, which requires that the subscriber should operate a machine and send his call automatically to the central office, can successfully compete with the plan which requires that the subscriber should move the telephone from the hook and send the call orally to an operator at the central office."

ELECTRICAL DESIGN & Manufacture

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Self-exciting Alternators.

The self-excited alternator has never been built in large sizes, and machines above about 50-kw. have accordingly been generally separately excited. The design of the self-excited machine has, however, always been a matter of extreme interest, and many valuable contributions have from time to time been made to the theory of the subject. A useful paper dealing with a special self-excited alternator was recently presented by Mr. E. F. Alexanderson to the American Institute of Electrical Engineers, and an abstract of the author's main points will be found valuable for reference.

The principles which must be borne in mind in the design of self-exciting compounded alternators are:

1. The commutation must be satisfactory with a load of any character, without shifting the brushes.
2. The compounding must be arranged so that armature reaction is compensated for, not only with variations of the load, but also for changes in power-factor.

It will be shown that both of these conditions can be obtained without departing from the simplicity of a single field winding of the ordinary type which carries a direct current and is fed from two terminals connected to a rectifying commutator. Any standard type of field winding as at present applied to the ordinary type of alternating-current machinery can therefore be used with this system.

A general diagram of the author's type of alternator is shown in Fig. 1. The exciting current is generated in an auxiliary three-phase winding placed in the same slots as the main armature winding. The terminals of this auxiliary winding are connected to three sets of brushes that bear on a rectifying commutator of special type. This commutator has one active segment per pole, covering practically two-thirds of the pole-pitch, the remaining one-third of the arc being insulated. Each alternate segment is connected to one terminal of the field winding and the remaining segments to the other. By this arrangement it is possible to make the commutation independent of the reactance which is inherent in the ordinary type of field winding, and the whole process of commutation is carried out in the stationary circuits before the current enters the field.

The voltage generated in the auxiliary winding is sufficient to supply current for excitation at full inductive load; and the excitation is adjusted to the proper no-load value by a three-phase rheostat inserted in the neutral point of the auxiliary winding. Automatic compounding is accomplished by means of a series transformer connected to the rheostat. The transformer sends a current through the rheostat in a direction opposite to the field-current, thereby eliminating the voltage drop in the rheostat. The elimination of the voltage drop in the rheostat changes over more or less of the field current from the rheostat to the series transformer. The secondary current of the series transformer is in phase with the line current, while the field current is practically in phase with the voltage. The amount of boosting in the field circuit will therefore depend not only upon the value of the secondary current, but also upon the power-factor of the load. A function of the rheostat which is just as important as the field control is its influence on the commutation. As far as commutation is concerned, the full resistance of the rheostat may be considered as always being in circuit, although the larger part of the field current may flow through the series transformer.

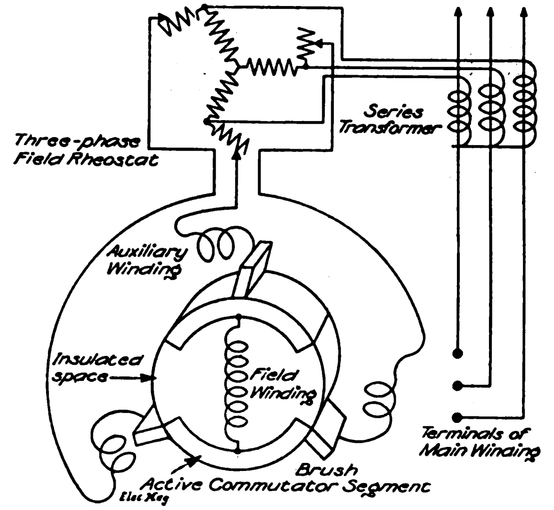
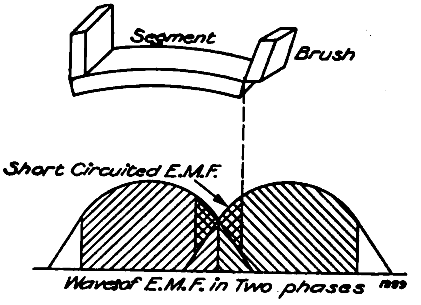


Fig. 1.
General Diagram of Alternator Connections.



As the phenomenon of commutation with this kind of rectifying commutator is entirely different from that with the ordinary multi-segment commutator of a direct-current machine, it may be of interest to enter somewhat further into the theory of commutation in the new type of alternator. In order to understand the operation of the commutator it must be borne in mind that the field winding carries a continuous current in spite of the fact that the impressed voltage is of a pulsating character. The only fluctuation that can occur is the quite negligible pulsation needed to induce a voltage large enough to overcome the ohmic resistance of the winding. The current in the three phases of the exciting circuit is not an alternating current of the regular sinewave shape, but is formed of pieces, so to say, cut off from the direct current. The commutation consists in changing over the direct current from one phase of the exciting circuits to another, and occurs when one brush has come in contact with a segment and another brush is ready to leave the same segment and run into the dead part of the commutator. At this instant the current must be changed in the brush which enters the segment from zero to full value of the direct current; and the current in the other brush must be reduced from maximum to zero. Commutation should occur a little later than at the moment in which the induced voltages are equal in the two phases undergoing commutation. If we imagine that one of the brushes is leaving the segment when the voltages are exactly equal, that brush would be yet carrying a part of the field current and this current would suddenly be interrupted and changed over to the other circuit. If the stationary circuit has a high reactance the sudden change of the current would induce a voltage between the brush and the segment, and thereby cause a spark. The moment of commutation should therefore be delayed to such an extent that the difference in voltage between the two phases begins to force a cross current through the completed circuit formed by the two phases and the rheostat. As soon as the two brushes are in contact with the same segment they naturally divide the field current; but the cross current which is superimposed on the field current will weaken the current in one of the phases and strengthen it in the other phase. If, therefore, the cross current is half as large as the field current at the moment of rupture, one of the phases will carry the entire current and none will pass through the brush which is leaving the segment. In this way complete commutation has taken place just before the brush leaves the segment, and consequently no sparking will occur. The time which is required for the cross current to reach the value of one-half of the field current depends upon the reactance and resistance in the external stationary circuit.

From the preceding it is evident that whatever be the values of these quantities a position can be found for the brushes where commutation will occur without sparking. But it is also evident that a slight variation in the position of the brushes may cause severe sparking if the circuits are not properly designed. If the circuits consist of a winding with very small resistance and high reactance, a small difference in voltage will cause a large cross current to flow between the two phases, and this cross current cannot be broken suddenly without sparking. In order to obtain successful operation of the commutator the generating circuit should be designed with as little reactance as possible and with a considerable amount of resistance.

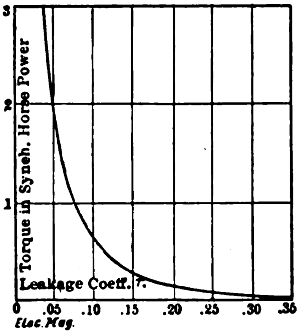


FIG. 1.

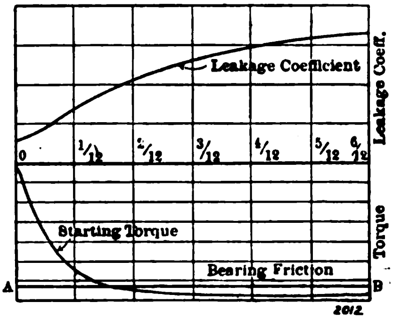


FIG. 2.

The effect of each of the different conditions which influence commutation has been determined experimentally. The most important of these conditions are :

1. Effective voltage across the brushes.
2. Effective voltage of the auxiliary winding.
3. Resistance of the stationary exciting circuit.
4. Reactance of the stationary exciting circuit.
5. Current density in brushes.
6. Velocity of commutator.
7. Amount of direct current taken from commutator.

The above quantities simply affect commutation in determining the extent to which the brushes may be shifted without causing sparking. The method of investigating how these several factors influence commutation has been to vary one quantity at a time, meanwhile keeping all the others constant. In general the results show that the range over which the brushes may be shifted without sparking is inversely proportional to the voltage across the brushes and, up to a certain limit, almost directly proportional to the resistance in the stationary exciting circuit. It is also an interesting fact that commutation is independent of the current taken from the commutator, if the voltage of the auxiliary winding and the resistance of the rheostat are kept constant.

◆

Starting Torque of Induction Motors.

By R. E. HELLMUND.

MOST of the publications treating of the starting conditions of induction motors deal with the determination of the average starting torque; that is, the average of the torque values which the rotor gives in its various positions. This value, however, is of little practical importance, since experience shows that in a motor which may have a good average starting torque, the torque for certain rotor positions is so small that the motor does not start up from such positions even under no-load. It is, therefore, very important to predetermine the value of the smallest starting torque, which may be called the "commercial starting torque." The purpose of this article is to deal with this question.

The only quantity having effect upon the change in the torque which takes place with variations in the rotor positions is the magnetic leakage, due to the changes in the zig-zag and belt leakage, the reluctance of the main flux bath being practically constant in most cases. It can easily be shown that the starting torque can be expressed in synchronous watts as the copper loss in the secondary conductors. Since with a certain value of primary and secondary resistances the secondary current at starting decreases with an increase of magnetic leakage, it will be appreciated that the starting torque, which is proportional to the square of the secondary current, decreases very rapidly with increase of the leakage.

In order to show how much the starting torque of the same motor may change for different rotor positions, there is shown in Fig. 1 a curve giving the values which the torque may assume for different values of the leakage coefficient. The upper curve in Fig. 2 gives the values which the leakage coefficient may assume in a three-phase motor with one slot per pole per phase in the stator and in the rotor, while the rotor occupies positions extending over a distance of only one-half of the tooth pitch.

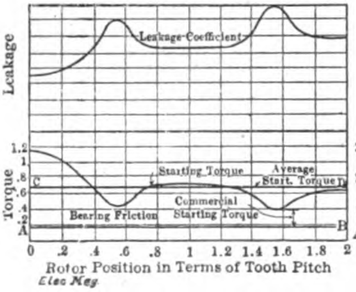


Fig. 3.

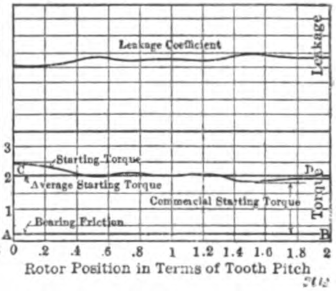


Fig. 4

From this curve and that of Fig. 1 is derived the lower curve of Fig. 2, which shows the torque exerted by the rotor as a function of the rotor position. The straight line A B shows the torque which is necessary to overcome the bearing friction of this motor. It is obvious that the motor will not start up even under no-load from all rotor positions for which the curve is below the line A B, while for the other rotor positions the torque of the motor is proportional to the distance between the line A B and the curve. The commercial starting torque of this motor is zero, while the average starting torque is fairly good. This case is, of course, more unfavourable than any which occurs in practice.

The upper curve of Fig. 3 shows the leakage of a four-pole three-phase motor with four slots in the stator and in the rotor as a function of the rotor position as derived under certain assumptions from a curve given by Prof. C. A. Adams in his paper on "Leakage Reactance of Induction Motors."*

The torque of this motor for various rotor positions is given by the lower curve in Fig. 3. The average torque is 3730 synchronous watts, corresponding to 5 synchronous horse-power; while the commercial starting torque is only 1790 synchronous watts, corresponding to 2.4 synchronous horse-power; that is, 48 per cent. of the average.

Similar curves are given in Fig. 4, for another four-pole three-phase motor with four slots per pole per phase in the rotor and in the stator. The average starting toque is here 1515 synchronous watts, corresponding to 1.9 synchronous horse-power; while the commercial starting torque is 1230 synchronous watts, corresponding to 1.6 synchronous horse-power—that is 87 per cent. of the average.

In this connection it may be shown that the choice of a small "largest common divisor" between stator and rotor slots is in reality not so important as usually assumed. If, for example, the motor, for which the torque is shown in Fig. 4, would be built with 16 poles while the other characteristic data stay the same, the commercial starting torque would be again 87 per cent. of the average, in spite of the very large common divisor, 4 × 3 × 16 = 192. In contradistinction to this result, the motor of Fig. 3, if built with 2 poles, has a common divisor of only 6, and the commercial starting torque is zero. It is very important, therefore, to know the value of the largest possible leakage coefficient of a motor, in order to predetermine its exact commercial starting torque.

After this it is possible to predetermine the commercial starting torque by simply using this largest possible leakage coefficient as basis of the calculation of the starting torque.—Abstracted from *Electrical World.*

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* Transactions of the International Electrical Congress, St. Louis, 1904; Vol. I., page 706.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The Mechanical Equivalent of Light.

By EDWARD L. NICHOLS.

(Continued from p. 266.)

ANGSTRÖM'S method for the determination of the mechanical equivalent, like that of Tumlirz, consists of two operations: the determination of the radiant efficiency of the Hefner flame and the measurement of the total radiation. His method of finding the radiant efficiency consists essentially of the dispersion of the rays from an incandescent lamp of special construction by means of the mirror spectroscope M P M (Fig. 3), the removal of the infra-red portions of this spectrum by means of an adjustable wedge E—the edge of which could be brought into coincidence with the boundary of the visible spectrum in the red at wave length .76—the reassembling of the visible portions of this spectrum by means of the cylindrical lens C and the measurement of the intensity of light thus brought to focus by means of a bolometer B. The effect upon the bolometer was compared with that produced by a Hefner lamp so placed as to produce an illumination precisely equivalent to that from the incandescent lamp. To secure this adjustment a photometer consisting of an equilateral prism of chalk, enclosed in a circular black box with circular openings, was mounted in place of the bolometer. This prism was so placed that one face would be illuminated by the reassembled light from the visible spectrum of the incandescent lamp, the other by the light of the Hefner lamp. This form of photometer is very sensitive to small differences of colour, and it was therefore possible to adjust the current through the lamp so that the character of the light emitted by it would correspond exactly with that of the Hefner flame. The distance of the Hefner lamp from the photometer could then be adjusted until the illumination on the two faces of the photometer prism was equal. The photometer was now removed and the bolometer mounted in its place. The energy reaching it from the incandescent lamp was that of a visible spectrum precisely equal to the visible spectrum of the Hefner lamp, while the energy reaching it from the latter included likewise the non-luminous energy of the infra-red spectrum. The careful comparison of these two bundles of rays, which are physiologically identical, gave the value of the radiant efficiency—namely, the ratio of the light-giving to the total radiation from the flame. This ratio, corrected for the various sources of error, such as losses by absorption and reflection, was found to be .0096, a value much smaller than that obtained by Tumlirz or by any of the other numerous observers of radiant efficiencies of similar sources who have made use of the water cell. That results obtained by the latter method are necessarily much too large has already been shown.

For the determination of the total radiation from the Hefner flame Angström employed his pyrheliometer, a form of differential bolometer well adapted for such purposes. In this instrument similar strips of metal, forming two arms of a Wheatstone's

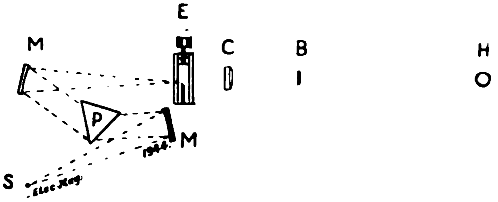

FIG. 3.

bridge, are mounted side by side. The change of resistance of one of these, which is exposed to the radiation to be measured, is counterbalanced by sending a sufficient current through the other strip to heat it to precisely the same temperature. In this way the energy received by the exposed arm can be determined in absolute measure. Angström found the radiation received upon one square centimetre of surface at a distance of one metre from the flame in the horizontal plane to be .0000215 gram calories per second. The luminous radiation from the flame is therefore

$$L = .0096 \times .0000215 = 20.6 \times 10^{-8} \frac{\text{gram calories}}{\text{seconds, cm.}^2}$$

This quantity, as is to be expected from the smaller value for the radiant efficiency, is much less than that obtained by Tumlirz. The latter observer, as has already been stated, recognised the more exact character of the dispersion method subsequently employed by Angström, but rejected it on account of the great difficulty of the adjustments. It becomes of interest to inquire therefore whether Angström's value is really more accurate than that of his predecessor or whether he has, on account of the experimental difficulties of the method, fallen into errors as great as those involved in the method of the water cell.

We may note in the first place that the smaller result obtained by Angström is in the direction of greater accuracy; and we are happily able to test its accuracy in a fairly rigorous manner by comparing the radiant efficiencies thus determined with those obtained by still another method, which, while it involves equally serious experimental difficulty, is exact when properly carried out. This method consists in the exploration of the entire spectrum with a sufficiently delicate instrument, such as the bolometer or radiometer, the plotting of the curve for the distribution of intensities, and the comparison of that portion of the area of this curve which represents luminous energy with its total area. The visible spectrum of the Hefner lamp is so feeble that accurate measurements of this portion of the curve are almost impossible. In the case of a more powerful source of light, such as the acetylene flame, it is, however, possible to explore the visible as well as the invisible spectrum, and to obtain a curve from which the necessary integrations can be made.

The radiant efficiency of the acetylene flame determined by the method of the water cell* ranges between .08 and .105. The values obtained by integration of the energy curve lie between .033 and .045. Angström by the same method which he applied to the Hefner standard found .056. The discrepancy between these values is much less than that between Angström's value and those obtained with the water cell. It may, indeed, perhaps be entirely accounted for by differences in the character of the flames employed.†

Angström also made use of his apparatus for the determination of the distribution of energy in the visible spectrum of the Hefner flame by moving the wedge S (Fig. 3) to different positions and measuring for each position the luminous energy included between the edge of the wedge and the violet end of the spectrum. From Wien's Law it is possible from a series of such measurements to compute the distribution of intensities throughout the region explored and in this manner to obtain the energy curve even where the various wave lengths are too feeble to be measured separately. The great value of such a curve lies in the fact that from it the corresponding curves of all sources of light which have been compared by means of the spectrophotometer with the Hefner standard may be readily computed. The curve for the acetylene flame thus obtained is found to be identical with that obtained by direct measurements with the bolometer, and this coincidence affords the strongest evidence of the substantial accuracy of Angström's values for the mechanical equivalent of light.

(*To be continued.*)

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* Nichols: *Physical Review*, Vol XI., p. 215.

† Nichols and Coblentz: l.c.

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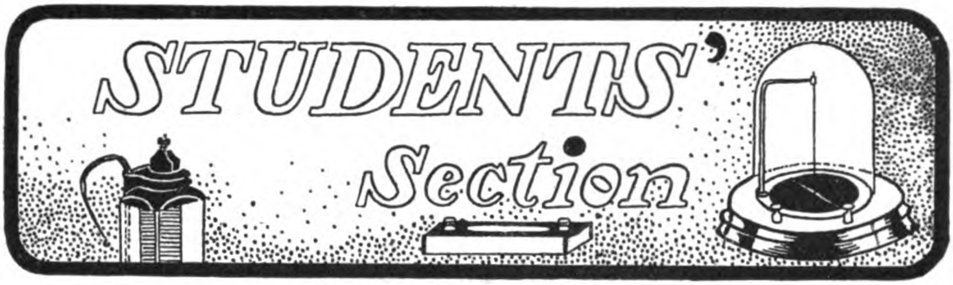


Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Simple Diagrams for Three-phase Power Calculations.

By ALFRED STILL.

IN this article it is not proposed to describe the various methods available for measuring the true power of a three-phase circuit; it is assumed that the conditions of load are known, together with the actual values of the various currents and pressures, and the phase relations between them.

By the use of vector diagrams, the writer hopes to explain in a clear and simple manner what is to be understood by the real and apparent power of a three-phase circuit under various conditions as regards load, such as may be met with in practice. There is no doubt that the majority of electrical engineers have a perfectly clear understanding as to what is meant by the power factor of a three-phase circuit *when the load is balanced;* but when the currents in the three conductors are not equal, it is by no means easy to define what is meant by the *apparent* power, although the *real* power can easily be measured.

Now, the power factor is the ratio of the true to the apparent power, and it becomes a matter of some doubt, therefore, as to what must be understood by the power factor of an unbalanced circuit. The method adopted by the writer, and which he believes to be new, consists in obtaining the true power, and an imaginary quantity which he calls the "wattless" or "idle" power, respectively, from a couple of measurements made on the diagram. With this data the power factor is readily calculated.

Before describing the construction of the diagrams for the more complex case of an unbalanced load, it will be advisable to consider briefly the more usual condition of equal currents in the three conductors.

When the load is *non-inductive* and *balanced*, as would be the case if the three phases were each supplying the same number of incandescent lamps, the vector diagram is extremely simple, and may be drawn as in Fig 1. Here $\overline{ab}$, $\overline{bc}$, and $\overline{ca}$ are the three vectors representing the pressures between terminals. They will form a closed equilateral triangle, which, when the *direction* of the vectors is taken into account, corresponds to three equal pressures having a phase angle of 120 degrees between them.

The three current vectors $\overline{a\,I_a}$, $\overline{b\,I_b}$, and $\overline{c\,I_c}$, if produced, will meet at the common point o, which is the centre of the triangle; and, if the generator armature windings were star connected, the dotted vectors $\overline{oa}$, $\overline{ob}$, and $\overline{oc}$, would correctly represent the pressures in the three armature sections.

It will be noticed that these pressures,

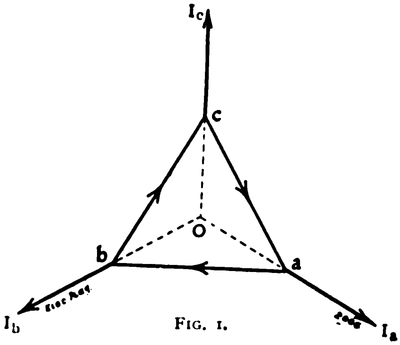


FIG. 1.

being in phase with the corresponding line current, fulfil the requirements of a balanced non-inductive load.

The total power of the three-phase circuit is three times $\overline{oc} \times \overline{cI_c}$, which may be written

$$3\ e\ I$$

or

$$\sqrt{3}\ E\ I$$

where e stands for the pressure between neutral point and any one terminal, and E is the pressure between line wires, while I represents the amount of any one of the three (equal) line currents.

Load Inductive, but Balanced.

In Fig. 2 the load is still supposed to be balanced; but it is partly inductive, and the current now lags behind the pressure e by the angle θ. This diagram, therefore, represents the condition of things in a three-phase circuit of which the load consists entirely of induction motors.

The total power is

$$3\ e \times I\ cos\ \theta$$

or

$$\sqrt{3}\ E \times I\ cos\ \theta.$$

while the power factor is

$$\frac{c\,C}{c\,I_c}, \text{ or } cos\ \theta$$

Non-inductive Unbalanced Load.

In Fig. 3 the diagram has been drawn for a non-inductive but *unbalanced* load. This condition of things might be produced by unequally loading the three phases with incandescent lamps.

It will be seen that the current vector I_c is in advance of the pressure vector $\overline{oc}$, while the other two current vectors, I_a and I_b, lag behind the corresponding "star" pressure vectors.

If we draw the star vectors from the centre o, and produce them outside the triangle, we have merely to project upon them the current vectors, and then calculate the power by the expression

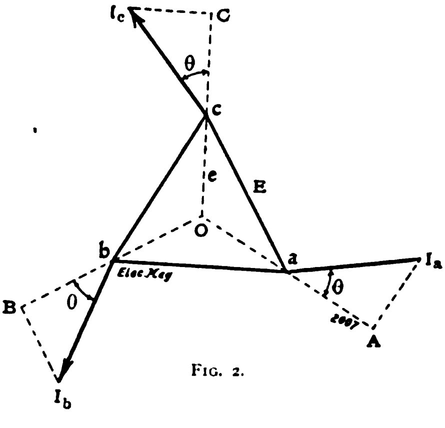


Fig. 2.

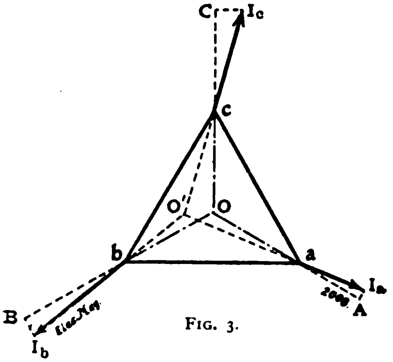


Fig. 3.

$$P = (\overline{oa} \times \overline{aA}) + (\overline{ob} \times \overline{bB}) + (\overline{oc} \times \overline{cC})$$

which may also be written

$$P = e\ (\overline{aA} + \overline{bB} + \overline{cC})$$

where e is the pressure measured between the neutral point o and any of the three terminals; its value is always E if E is the pressure between line wires, represented by the sides of the pressure triangle a-b-c. It should be observed, however, that, since the load is non-inductive, there must be a set of three vectors *in phase* with the three currents, and it will be found that if we produce the current vectors inside the triangle they will meet at a common point o'.

This gives us a new set of equivalent star vectors, $\overline{o'a}$, $\overline{o'b}$, and $\overline{o'c}$, each in phase with the corresponding line current; and the total power can, therefore, also be written

$$P = (\overline{o'a} \times \overline{aI_a}) + (\overline{o'b} \times \overline{bI_b}) + (\overline{o'c} \times \overline{cI_c})$$

All the foregoing diagrams have been drawn on the assumption either that the generator armature windings are mesh connected, or that if star connected, no fourth conductor is brought back from the load to the neutral point. The vectorial sum of the three currents, I_a, I_b, and I_c, must therefore be zero, and, indeed, if the vectors $\overline{aI_a}$, $\overline{bI_b}$, and $\overline{cI_c}$, in any of the diagrams, are combined together, they will be found to form a closed triangle. This particular relation between the three currents in the line wires is evidently necessary to fulfil the condition that the sum of all currents *leaving* the source of supply must exactly equal the sum of all currents *returning* to the source of supply.

We may now consider the question of an unbalanced but partly inductive load; bear-

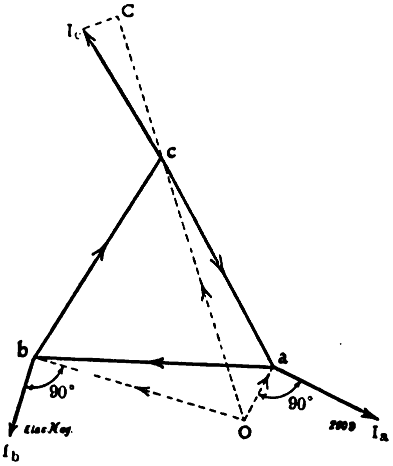


FIG. 4.

ing in mind that this condition has still to be fulfilled, namely, that since we are supposing only three wires to connect the load to the source of supply, any one of the three currents must necessarily be equal but opposite to the (vectorial) sum of the other two.

General Problem: Unbalanced Inductive Load.

In Fig. 4, the three unequal current vectors I_a, I_b, and I_c, indicate that the load is not balanced. In Fig. 3, the current vectors were also of unequal length, but they met at a common point o', thus showing the load to be *non-inductive.* The essential difference between Figs. 2, 3, and 4 is that in the latter diagram if we extend the current vectors backwards, they will not meet at a common point, and this indicates that the load must be partly inductive.

A diagram such as the one drawn in Fig. 4 might represent a load consisting partly of inductive motors on the three phases, and partly of incandescent lamps across one or two phases, or unequally across all three phases.

The total power might be calculated from the diagram by drawing the star-pressure vectors radiating from the centre of the triangle, and projecting upon them the corresponding current vectors in the manner explained in connection with Fig. 3. It should, however, be pointed out that any system of three vectors radiating from a common point o, and terminating at the vertices a, b, and c, of the pressure triangle, may be used to replace the sides of the triangle. The pressures between the line conductors are necessarily equal to the *differences* between the pressures measured outwardly from the common point o, whatever may be the exact location of this point, and we may, therefore, write

Pressure on phase $a = \overline{oa} - \overline{oc} = \overline{ca}$
,, ,, ,, $b = \overline{ob} - \overline{oa} = \overline{ab}$
,, ,, ,, $c = \overline{oc} - \overline{ob} = \overline{bc}$

It is possible to choose the point o so that only two measurements and a single multiplication will give the total power of the three-phase circuit. This can be done by drawing ob at right angles to $b\,I_b$, and oa at right angles to $a\,I_a$. The total power is the sum of the three products

$\overline{oa}$ × the projection of $\overline{a\,I_a}$ on $\overline{oa}$
$\overline{ob}$ × ,, ,, ,, $b\,I_b$ on ob
$\overline{oc}$ × ,, ,, ,, $c\,I_c$ on oc

but, since the point o has deliberately been chosen so as to make the first two products equal to zero, we have for the total power of the three-phase circuit

$$P = \overline{oc} \times \text{the projection of } \overline{c\,I_c} \text{ on } oc$$
$$= \overline{oc} \times \overline{cG}.$$

Power Factor of Unbalanced Load.

It is not easy to state exactly what is to be understood by the power factor of an unbalanced three-phase load, because—although the true power is readily calculated as already explained—the *apparent* power is no larger quantity which can be readily calculated as in the case of a single-phase circuit, or a balanced polyphase system.

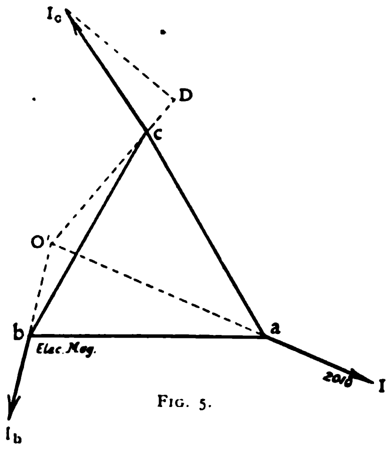


FIG. 5.

The most convenient way of looking at the problem with a view to determining the extent to which an unbalanced three-phase circuit is inductive, is to consider the *apparent* power as being made up of two quantities—the real power and the "wattless" or "idle" power, this last being an imaginary quantity of such a commercial value as to fulfil the condition.

$$\text{apparent power} = \sqrt{(\text{real power})^2 + (\text{“idle” power})^2}$$

the ratio $\frac{\text{real power}}{\text{apparent power}}$ being the *power factor* of the unbalanced load.

Referring to Fig. 1, this quantity to which we have given the name of "idle" power is evidently zero.

$$\text{In Fig 2 it is } e\,(\overline{AI_a} + \overline{BI_b} + \overline{CI_c})$$
$$\text{or } 3\,eI \sin\theta$$
$$\text{In Fig. 3 it is } e\,(\overline{I_aA} + \overline{I_bB} - \overline{I_cC})$$

where the minus sign indicates that the wattless current component $I_c\overline{c}$ is *leading*, while the other two, $\overline{I_aA}$ and $\overline{I_bB}$, are *lagging*. [In this particular case—the load being non-inductive—the length $\overline{I_cC}$ will necessarily be equal to $\overline{I\,A} + \overline{I_bB}$, and the "idle" power will, therefore, be zero.]

In Fig. 4 the equivalent of the "idle" power may be written

$$(\overline{ob} \times \overline{bL_b}) + (\overline{oc} + \overline{I_cC}) - (\overline{oa} \times \overline{aI_a})$$

but this quantity may be calculated more easily by means of the construction shown in Fig 5. Here the pressure triangle and current vectors are exactly similar to those in Fig 4; the only object in drawing a separate diagram being to avoid a multiplicity of lines in Fig. 4.

Another common point o' has been selected, from which the equivalent star vectors radiate to the points a, b; and c. It is obtained by producing the current vectors I_a and I_b until they meet.

The "idle" power can now be calculated from two measurements only, and it is equal to

$$\overline{o'c} \times \overline{I_cD}.$$

Reading the two diagrams, Figs. 4 and 5, as if they formed but one, we may, therefore, write

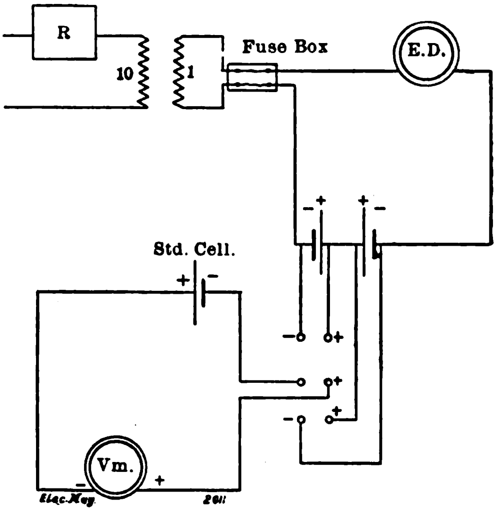
$$\text{power factor} = \frac{\overline{oc} \times \overline{cC}}{\sqrt{(\overline{oc} \times \overline{cC})^2 + (\overline{o'c} \times \overline{I_cD})^2}}$$

—From *Power*.

Maximum Efficiency of a Storage Battery.

By BENJ. F. BAILEY.

THE following test was conducted in the laboratory of electrical engineering at the University of Michigan by E. M. Gladden and B. A. Baker under the supervision of the writer. The object of the test was to get the highest possible efficiency from a storage battery. It is well known that the efficiency increases as the periods of charge and discharge are made shorter, and in order to make these cycles very short we used a 60-cycle alternating current furnished from the city mains at 110 volts.



As shown in the figure, we passed this current through a rheostat and the primary of a 10-to-1 transformer. From the secondary of the transformer we sent the current through a fuse-box to an electro-dynamometer by means of which we determined the current and kept it constant at 20amp. by varying the resistance in the primary circuit. From the electro-dynamometer the current passed to the storage battery consisting of two 160-amp.-hour cells, with a normal discharge rate of 20amp. These were connected in opposition so that they might not discharge through the transformer. We used a double-pole, double-throw switch connected as shown, to facilitate comparisons of the voltage of our test cells and a cell which we used as a standard and left upon open circuit except when taking readings. The differences in voltage were so small that we connected the test cell in opposition to our standard and measured the difference in voltage with a millivoltmeter. This instrument read from 0 to 300 and gave a deflection of about two-thirds the scale.

At the beginning of the test the voltage of the standard cell was 2.074, No. 1 was .0055 volt greater and No. 2 was the same as the standard. All these cells discharged gradually, but the test cells, with the alternating current passing through them, less rapidly than the standard which remained on open circuit. The difference between No. 1 and the standard was practically constant for about fifty hours, during which time No. 1 was probably discharging slightly into No. 2 through the transformer, for at that time No. 2 had gained until it was .0036 volt ahead of the standard. From that time on the e.m.f. of the two test-cells fell off at nearly the same rate until, at the end of the test, 128.5 hours after starting, No. 1 was .0068 volt and No. 2 .0050 volt ahead of the standard, whose voltage had dropped to 2.072 volts. The voltage of the standard had been as low as 2.058 volts, but the temperature, which varied between 55deg. and 65deg. F., was probably high at the end of the test.

The quantity of electricity passed in the two directions certainly averaged the same. Consequently this test shows that the ampere-hour efficiency of a storage cell when worked with very short cycles of charge and discharge is almost exactly 100 per cent. In fact, the loss of charge is not so great as in a cell standing upon open circuit.

We next investigated the watt efficiency of the cell under the same circumstances. We measured the alternating voltage and watt loss at the terminals of the two test cells, and, using a 20-to-1 multiplier to make the deflections readable, we got no appreciable voltage. The loss at sixty cycles per second was 1.35 watts, giving the high efficiency of 98.1 per cent. by the formula:

$$\text{Efficiency} = \frac{\frac{I}{1.11}E - \frac{W}{2}}{\frac{1}{1\cdot 11}E}$$

In which I = total current.
E = e.m.f. of one cell.
1.11 = form factor = ratio of effective current to average current.
W = total watts lost and $\frac{W}{2}$ = loss per cell.

I was 20amp. and E averaged 2.07 volts. In getting the watt efficiency we assumed, by using 1.11 as the form factor, that the voltage curve was a sine curve, which is approximately correct, and the difference in efficiency is negligible. The specific gravities of the cells showed greater density for the first thirty hours. Probably the decrease in temperature, also indicated by the drop in voltage of the cells, more than made up for the discharge, and this caused the specific gravity to rise. The average densities were as follows: Cell No. 1, 1.1777; No. 2, 1.1732; standard, 1.1702. The average of all was 1.1737.

On page 113 of Lyndon's "Storage Battery Engineering" the author says: "In passing alternating current of various frequencies through two electrodes immersed in dilute sulphuric acid, . . . at low frequencies, the deposit was brown peroxide, and at high frequencies, white sulphate only was produced, which fell from the plates as fast as formed. In the former case the time of one impulse was long enough to form sulphate and change it into peroxide; in the latter the impulse lasted only long enough to form the sulphate, which was thrown off on the succeeding impulse in the opposite direction."

No deposit of any kind was noticeable in our experiment and the cells showed no injury.

In addition to the long test we ran a short one to show the effect of various frequencies with the current constant at 20amp.; it was as follows: 10 cycles, 97.4 per cent.; 25 cycles, 97.3 per cent.; 35 cycles, 97.6 per cent.; 60 cycles, 97.8 per cent.; 120 cycles, 97.8 per cent. As was expected, the efficiency increases slightly as the frequency becomes greater. In a storage cell we have at least two losses, an I^2R loss and a polarization loss. Apparently with very short cycles of charge and discharge, the polarization does not have time to manifest itself and we have the I^2R loss only.—From *Electrical World.*

Students, Write at Once
ordering our Great International Number. You will be disappointed if your order is not booked early.

From Professor to Student.

Could you tell me of any book dealing with the electrical behaviour of carbon?

Our correspondent's query is somewhat vague, as he does not state what particular practical application of carbon he is interested in; but probably Jehl's "Carbon Making for all Electrical Purposes" (published by the Electrician Printing and Publishing Co., Ltd., price 10s. 6d.) would furnish him with the necessary information.

What is the proper size of transformer for the following systems, assuming 100 kilowatts to be the load upon the circuit? Each transformer on a three-phase, three-wire system; each transformer on a three-phase, four-wire system; each transformer on a three-phase system with the Scott method of transformation from three to two phase.

The proper size of transformers would be as follows: Each transformer on a three-phase, three-wire system, 33⅓kw.; each transformer on a three-phase, four-wire system, 33⅓kw.; transformers on a three-phase system employing the Scott method of transformation from three to two phase, one 50kw. and the other 1/7 larger. It will be necessary for you to choose standard transformers having capacities which are nearly proportional to the above.

Kindly inform me why with two transformers operated in multiple, if the secondary of one be grounded an accidental ground from the opposite side of the secondary of the other transformer would not result in current flowing from that side of the secondary of one transformer to the opposite side of the secondary of the other transformer.

The secondary circuit of each transformer with its group of lamps is a system in itself and is not affected by grounds on other transformers in circuit with it.

Is it possible to measure the voltage across an arc of a 3000-volt series system with a common 300-volt instrument, the lamps consuming 6.6 amperes at 72 volts?

Yes. In performing this operation, however, it is absolutely necessary that all the lamps be lighted and remain so, and also that the person making the measurement should be insulated from the ground. Unless these conditions obtain, there is an attendant danger. Should the arc across which the measurement is being taken fail, the full potential of the system will be thrown on the instrument, and unless caution is used and the operator insulated from the earth, current at this potential might pass through him to earth with serious results.

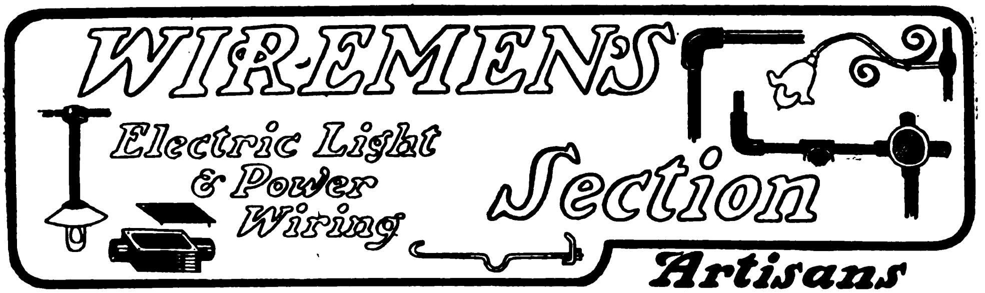
Kindly explain how a 60-cycle transformer will work on a 125-cycle circuit or a 125-cycle transformer on a 60-cycle circuit?

The counter e.m.f. of the primary, which almost equals the impressed e.m.f., is numerically proportional to the product of the magnetic lines of force in the core, the number of cycles and the turns in the primary winding. When a 120-cycle transformer is operated on a 60-cycle circuit of the same voltage, this counter e.m.f. is nearly the same as on a 120-cycle circuit. The magnetic flux however is nearly doubled and the magnetising primary current is almost three times as great as that required on the 120-cycle circuit. The result of the change in frequency from 125 cycles to 60 cycles would be to double the magnetic density in the core and increase the no-load primary current about 200 per cent. The increase in power loss as distinguished from the increase in primary current will be approximately one-third in the core and very little in the primary winding at full load; so that if a transformer showed losses of 3 per cent. on 125 cycles, the losses at 60 cycles would be about 4 per cent.

Is it possible to obtain a relation between the quantities concerned that shall give the most efficient voltage at which to run a transformer at a frequency other than that for which the transformer was designed?

The problem suggested by our correspondent possesses no practical interest, for reasons explained below, but a solution of it may readily be obtained if the necessary data are available—such as full constructional details of the transformer, and the hysteretic coefficient of its core. For a given frequency the maximum induction increases in proportion to the voltage. Let the core loss (including hysteresis and eddy-current losses) be calculated for a number of voltages. The core loss at any voltage being known, we can easily find, by determining the copper losses, the efficiency at various loads corresponding to a given voltage. On plotting the efficiency against the load, we find the maximum efficiency at that voltage. The maximum efficiency corresponding to each voltage having been found, we plot another curve, connecting maximum efficiency with voltage, and from this ascertain at what voltage the maximum efficiency has the highest value.

But the problem, as already stated, is of purely academical interest, and would never arise in practice, because (1) we have no choice as a rule with regard to voltage, but have to use whatever voltage exists across the supply mains; and (2) the output of a transformer is not determined by considerations of efficiency, but by the maximum permissible temperature rise.



Conduit Installation Work.

By L. M. WATERHOUSE.

INSULATED conduit has never found very much favour in this country, owing, to a certain extent no doubt, to its high and almost prohibitive initial cost. This type of conduit is looked upon by its adherents as giving increased insulation resistance to the circuit, and it is supposed to safeguard against damage through short circuits, internal arcs, or electrolytic effects. It must be borne in mind, however, that when insulated cable is used, the pole to pole insulation resistance of the circuit is in no way affected. The insulation resistance to earth, instead of being altogether on the rubber covering of the wires, is also now partly on the tube; but whereas the insulating covering of the wires is a very high-class grade of insulation, the insulating lining of the tube is nothing of the kind. The material, as far as I know it, is certainly not impervious to moisture, but absorbs it to an appreciable extent, and there is considerable difficulty presented, necessitating great accuracy in fitting if the insulating lining is to be made continuous throughout. We have also to bear in mind that the insulating lining has the effect of decreasing the capacity on any given size of metallic tubing.

I will now deal with some points in the conduit wiring of installations, on which it appears to me that discussions would be most valuable, both from the manufacturers' and contractors' point of view, and should ultimately lead to the betterment of installation work as a whole. I would first direct attention to an interim re-issue of the rules of the Royal Insurance Company. These rules, embodied by consent of the Council, are uniform in requirements with the rules of the Inst.E.E. On page 18 we have the following :—

> " In the opinion of this company the best general method of enclosing and protecting the conductors is by the use of stout metal conduits. It is important to note, however, that numerous fires have occurred through leakages of the current from such conduits to soft metal gas pipes, so that the security of such a system depends seriously upon the proper spacing apart of such conduits from soft metal gas pipes or from metal work in contact therewith."

This note deals with one of the real risks in connection with the conduit wiring of buildings, and a risk that will remain just so long as we continue to permit the use of gas pipes of the compo. description. Continuity and earthing, about which there has recently been so much correspondence and discussion, are no doubt very advisable on high-voltage work from the point of view of protection from danger to life, but are really very little safeguard against fire risk, unless care is taken to keep metal conduits spaced apart from such gas pipes, and, of course, from any metal work in connection with them. Incidentally, it may be remarked that while a conductor of small sectional area may be sufficient for earthing in respect to minimising the risk to person, it should be borne in mind that a fault on a main or submain may only be protected by a fuse many times too large to protect a small earthing conductor from dangerously overheating. Therefore, earthing wires should be of ample sectional area to carry a main current without dangerous heating.

The present chief engineer of Glasgow, Mr. W. W. Lackie, in his paper on " Earthing," read before the Glasgow Branch of the

Inst.E.E., in February last year, laid it down that conduits should be entirely insulated throughout a building. Now, I think this is most desirable, and if it were possible in practice I believe that it would at once remove the only real cause of uncertainty connected with the use of metal conduits. Without touching on the question raised by Mr. Lackie in his paper—viz., the introduction of a resistance in the earthing wire of a conduit installation—I should like to refer to some points which were brought out in that paper, and in the discussion, which to my mind are of considerable importance. First, we have an up-to-date report on fires having an electrical origin, and during three years, 1902-3-4, thirty-five fires were reported. On examination these were reduced to thirty-three or an average of eleven a year; this works out at one fire per 900 installations, and shows how essentially safe electric lighting is. Of these electrically-caused fires one-half (fifteen) were due to the melting of compo. gas tubes, where metal-sheathed cables were used. Now eight of these jobs were carried out without being properly earthed, and seven were properly earthed; what the other causes were does not particularly concern us at the moment, but the point I want to emphasize is that continuity and earthing alone do not, as is commonly supposed, safeguard against fire. Suppose we have a leak on one of the outers of a three-wire system the neutral of which is earthed, the tubing, if continuous, becomes alive throughout its length. Now the tubing may be earthed by an earth wire or not; it is quite possible that it may also be unintentionally earthed at one or more points, by contact with compo. piping; the result is that there is a large momentum rush of current to earth which splits up amongst the different earth paths in the ratio of their conductivities, and it is the arcing and consequent gas igniting effect of these earthing discharges which is the cause of danger. To entirely eliminate this we must insulate conduit runs as far as practicable from *all* metal work, or we must remove all compo. gas tube from the building.

Now there are many thousands of socket-joint installations erected during the last eight years which are to-day working very satisfactorily, but these have been erected without any attempt being made to secure continuity or bonding, and consequently they are not intentionally earthed. The Institution of Electrical Engineers, in their wiring rules, do not demand continuity and earthing in jobs where the voltage of supply does not exceed 250 volts. Their rule dealing with this rule 12 is important:—"Conductors conveying currents at pressures exceeding 250 volts must be completely encased in metallic sheathing or tubing efficiently connected to earth, and such sheathing or tubing must be electrically continuous throughout its length." The latter part is rather superfluous, for a run of tubing to be efficiently earthed must of necessity be continuous. We can draw the following deductions from this rule.

1st.—That metallic sheathing, continuous and earthed, is the only method permissible with conductors on high-voltage work.

2nd.—That it has not been deemed expedient to prohibit the use of socket joint tubing on voltages below 250.

I have been accused of reading into this rule my own interpretation, but I venture to say that I make no undue deduction. It has also been said that the rule is badly worded; but I think it reasonable to suppose, considering the long consideration given to these rules generally, that this rule in particular received special attention at the hands of the Committee, and I do not think we are justified in assuming that it is badly worded. The question arises—"Was it not purposely so worded?"—for the reason that a very large number of installations had been erected with a light gauge tubing which was neither continuous nor earthed, and the percentage of such installations which had been found faulty was a very small one indeed.—From a paper before the Electrical Contractors' Association.

* * *

Questions and Answers.

I HAVE a small dynamo, direct current, 40 amperes, 110 volts, which gets hot at the armature after running about one hour, and the lights get dim. Have about seventy lights on this machine, which is of the four-pole type, equipped with carbon brushes. Would you kindly tell me how to remedy this trouble?

A forty-ampere, 100-volt dynamo should be quite capable of handling at least seventy sixteen-candle-power lamps, and there should be no occasion for such a machine to show a temperature rise of more than 40deg. centigrade when operating under full load continuously. A rise of 40deg. centigrade is equivalent to a rise of 72deg. Fahr. and all such temperatures are taken above the temperature of the surrounding air. It is difficult to say what is the matter with the generator without an actual examination, but it is quite possible that the machine is simply rated at more than its normal capacity. Unless a person is very experienced, it is a difficult matter to estimate the rise in temperature unless a thermometer is used. We would suggest that you take the temperature of the windings on this machine with a thermometer, and the temperature of the air, to ascertain whether or not the rise is greater than that specified above. The fact that the lamps get dim after running for some time could be attributed to the machine running at a lower speed than that for which it is designed. Under such a condition, the field rheostat could be adjusted to give proper voltage when the machine was cold, but after a run of some hours the resistance of the field would increase to such an extent that sufficient current could not be forced through it to give full voltage at the brushes. We would suggest that you ascertain the proper speed at which this generator should run, and if same is now running below normal speed, change the pulley combination so as to remedy this trouble.

I understand that a three-phase generator can be operated as a single-phase machine. Has this peculiarity any advantage, and, if so, how much power can be obtained from a three-phase generator when operated as a single-phase machine?

Probably the system which gives the best results so far as incandescent lighting is concerned is the single phase, and on the other hand, either two or three phase is most adaptable for power purposes. The three-phase machine can be operated single phase and also three phase at the same time. This gives the three-phase machine a decided advantage in small plants, as the lighting can be taken off single phase and the power taken off three phase, thus giving the best possible arrangement of circuits. As a single-phase machine the three-phase generator was approximately seventy-five per cent. of its three-phase capacity. Where two or three phase lighting is used, difficulty may be experienced in balancing the phases, and regulators may have to be installed for the purpose. If the lighting be done from one phase of a three-phase machine, this phase is the only one which will require watching, and as the voltage of this phase may be controlled without regard to the other phases, in all probability this system will give the most satisfactory results.—From *Canadian Electrical News.*

Notes.

There seems to be a lot of doubt as to what will be the effect of the Bill now before Parliament to enable municipal authorities to defray the cost of wiring out of the local funds. These payments would, of course, be charged against the electric light undertaking, and no doubt the increase in current consumption would be sufficient to eventually reimburse the authorities. But the point is raised that the municipal authorities would carry out this work themselves and the contractor would have to go into the museum with the horse. On the one hand this is the cry of the contractor; on the other, the various bodies say that they would increase the work of the contractor by finding work and placing it in the contractor's hands to carry out.

* *

The point is, would they? Or would they find another means of dabbling in trade? If the local authorities are given power to defray the cost, but are compelled to place the work out to tender, the Bill is bound to be of assistance to trade, and would give electrical undertakings an opportunity of taking up small properties on a paying basis.

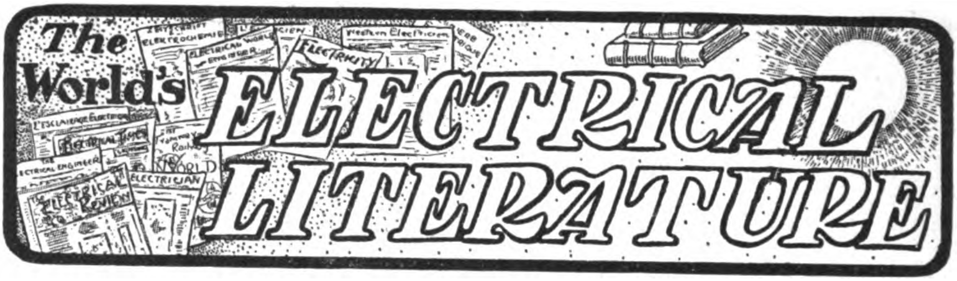
On this latter point it does seem absurd that in every case where current is supplied to what are generally known as half houses, and in which the lighting amounts to about five 16c.p. lamps, and no further possibility of extension, that an expensive meter and service is installed, effectually preventing the supply from ever receiving any pecuniary benefit. Cannot a rental per lamp be agreed upon?

DON'T TURN OVER.

Read This.

Foremen and others wishing to augment their income without in any way interfering with present employment would do well to write for particulars to "Amsoc," c/o THE ELECTRICAL MAGAZINE, 4, Southampton Row, London, W.C.

N.B.—No fees of any kind.



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Power.

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Wiring and Maintenance of Shunt and Compound Wound Motors. W. Kavanagh.	*Elec. Wld.*, 7/4/06.
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The Niagara-Syracuse Transmission Line. O. E. Dunlap.	*Elec. Wld.*, 14/4/06.
Hydro-Electric Development in the Adirondacks.	*Elec. Wld.*, 21/4/06.
10,000 h.p. Generators on Horizontal and Vertical Shafts. O. E. Dunlap.	*Westn. Electn.* 7/4/06.
The Bille Central Station, Hamburg. F. C. Perkins.	*Westn. Electn.* 14/4/06.
Electrical Operation in Silk Factories. A. Graelenwitz.	*Westn. Electn.* 21/4/06.

Papers.

Lifts and Hoists. H. C. Crews.	*Manchester I.E.E.* 10/4/06.
A New Method of Turbine Control. L. Lyndon.	*American I.E.E.* 9/4/06.

Traction.

Articles.

The Reconstructed Baltimore System.	*Str. Rly. Jrnl.* 21/4/06.
*Electric Traction on Main Line Railways in Europe. P. Dawson.	*Str. Rly. Jrnl.* 7/4/06.
Recent Decisions in Connection with Tramway Construction.	*Elec. Eng.*, 20/4/06.

Papers.

All Steel Cars. G. H. Sheffield.	*Trys. and St. Rlys. Assoc.*, 26/4/06.

Central Station Practice.

Articles.

Central Station Advertising. C. D. Marsh.	*Elec. Wld.*, 7/4/06.
Good Breeding in Advertising. F. B. Rae, Jr.	*Elec. Wld.*, 7/4/06.
New D.C. Switchboard Instruments. A. O. Benecke.	*Elec. Wld.*, 7/4/06.
Work of the Lewiston and Auburn Electric Light Co.	*Elec. Wld.*, 7/4/06.
Test of an Underground Armored Cable at 27,000 volts. MM. Geoffroy and Delore.	*L'Ind. Elect.* 10/3/06.
Regulating the Voltage of an A.C. Distributing System. J. Büchi.	*Elek. Zeit.* 15/3/06.
Some Notes on the Regulation of Rotary Converters. A. Still.	*Elec. Rev.*, 13/3/06.
Separation of Oil from Feed Water. J. H. Harwood.	*Elec. Rev.*, 13/3/06.

Papers.

Line and Station Protection against High Potentials. G. E. Palmer.	*Assoc. Elec. Lgt. Eng.*, 21/3/06.
Discrimination in Rates. J. S. Codman	*Assoc. Elec. Lgt. Eng.*, 21/3/06.
Best Methods of Advertising for Electric Light Companies. C. D. Marsh.	*Assoc. Elec. Lgt. Eng.*, 21/3/06.
Single Phase A.C. Motors *v.* Three Phase. W. Layman.	*Assoc. Elec. Lgt. Eng.*, 21/3/06.
Coal Testing. J. Holliday.	*Dublin I.E.E.* 5/3/06.
Notes on Booster Developments. A. H. Kelsall.	*Glasgow I.E.E.* 10/3/06.

Lighting and Heating.

Articles.

A Year's Progress in Illuminating Engineering. E. L. Elliott.	*Illumtg. Engr.*, *March*, /06.
Illuminating Efficiency *v.* Candle Power Efficiency of Electric Lamps. G. Loring.	*Illumtg. Engr.*, *March*, /06.
A New Method of Shop Window Lighting. P. H. Jachning.	*Illumtg. Engr.*, *March*, /06.
The Life of Incandescent Electric Lamps. P. S. Miller.	*Illumtg. Engr.*, *March*, /06.
A Portable Selenium Photometer for Incandescent Lamps. Dr. T. Torda.	*Electn.*, 13/4/06.
Variation of Candle Power due to Frequency. P. O. Keilholtz and B. H. Branch.	*Elec. Journal*, *April*, /06.
Lighting on 25 Cycles in Buffalo. H. B. Alverson.	*Elec. Journal*, *April*, /06.

Papers.

*Important Considerations in Electric Illuminating Engineering. D. Burnett.	*W. J. Ill., Eng. Soc.*, 12/4/06.
Long Flame Arc Lamps. L. Andrews.	*Inst. E. E.*, 26/4/06.

Telegraphy and Telephony.

Articles.

The Prevention of Pole Rot. C. H. Coar.	*Western Electn.* 21/4/06.
Trials and Dangers of the Lineman. R. G. Grayne.	*Western Electn.* 21/4/06.
Long Distance Underground Conduit System of American Telegraph and Telephone Company.	*Elec. Rev.*, *N.Y.* 14/4/06.
Wireless Telegraphy by means of Kites. W. Fawcett.	*Elec. Rev.*, *N.Y.* 7/4/06.
The Application of Self Induction to Long Distance Telephony. E.K.W.	*Elec. Eng.*, 6/4/06.

Electrical Design and Manufacture.

Articles.

*The Survival of the British Electrical Manufacturer. R. A. Brown.	*Elec. Wld.*, 14/4/06.
Method of Design for Magnet Windings. F. A. Willard.	*Elec. Wld.*, 21/4/06.
Graphic Representation of Induction Motor Phenomena. A. S. M'Allister.	*Elec. Wld.*, 21/4/06.
Maximum Efficiency of a Storage Battery. B. F. Bailey.	*Elec. Wld.*, 21/4/06.
Charlottenburg Conference of Electrical Units of Measurement. H. S. Carhart.	*West. Electn.* 14/4/06.
Design of Induction Motors. R. E. Hellmund.	*Elec. Rev.*, *N.Y.* 7/4/06.
Advantages of the Interpole Design in Railway Motors. G. H. Condict.	*Str. Rly. Journal*, 21/4/06.
Distribution of the Magnetic Flux in D. C. Machines with Commutating Poles. R. Pohl.	*Elec. Engineer*, 20/4/06.
Estimation of Reactance Voltage of C.C. Dynamos. H. M. Hobart.	*Electn.*, 20/4/06.
Effect of Steam and Smoke on Striking Distance. S. M. Kintner.	*Elec. Journal*, *April*, /06.

Papers.

The Testing of Transformers and Transformer Materials. D. K. Morris and C. A. Lister.	*Bhm. I.E.E.* 25/4/06.

Students.

Articles.

Design of a small Central Station. J. F. Hobart.	*Elec. Wld.*, 7/4/06.

Wiremen.

Articles.

Wiring with Flexible Conduit and Armoured Cable. L. J. Auerbacher.	*Elec. Wld.*, 7/4/06.
Good Wiring Practice on Cars.	*Str. Rly. Jrnl.* 21/4/06.
System in Wiring Work, N.O.R.A.	*Elec. Eng.*, 20/4/06.
Wiring with Lead-Covered Rubber-Insulated Wire.	*Elec. Rev.*, 20/4/06.

MANUFACTURING Progress

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Suction Gas Plant.

In the present times of severe competition and low prices all principals associated with commercial enterprises must necessarily pay particular attention to every means of reducing the manufacturing cost of their products. In some instances it is a matter of reducing the cost of labour by the introduction of labour-saving machinery, in others a revision of the method of producing power to operate these machines. It is generally admitted that the electric drive is the best where conditions demand the transmission of power to any distance, and where electric lighting is used and can be supplied from the power mains. When this is not available it may be generated on the spot, and of the present-day methods of generating power up to moderate sizes, nothing equals the gas engine as a prime mover when supplied with gas from its own suction plant. Where light and power are required the engine can be arranged to drive a dynamo, either directly coupled or by belt, and the combination makes up a very compact generating unit.

The suction gas producer is simple in its operation, the floor space occupied per horse power is very little. It is easily managed and gives no trouble if it receives reasonable attention. The plant requires practically no auxiliary apparatus such as is usually associated with steam. It is easily started up, and when properly designed is a highly efficient piece of apparatus. A great feature of the producer is that the supply of gas is made dependent entirely upon the demand made upon it by the engine itself.

A factor of importance is that the stand-by losses,—*i.e.* the losses due to banking up during periods of rest, &c., are very little. It must be mentioned here that many gas producers do not respond readily to fluctuations of load, but we understand this is not the case with the type of producer illustrated herewith, which is made by the Industrial Engineering Company, of 12, Exchange Street, Manchester, and Newton Iron Works, Hyde, for this point has received very careful attention, with the result that their producer responds most readily to variations of load with practically no difficulty.

As regards the cost of installing a plant meeting the above requirements, the outlay is extremely moderate, and we are informed that it is amply repaid by the economical results obtained under ordinary working conditions, in about three years from the date it is first put into commission. As to running expenses under normal conditions of load, the makers state that it is usual to generate one Board of Trade unit of electricity at the switchboard for a cost of under ½d., which includes fuel, engine stores, depreciation, and labour, and is to be further reduced if a moderately high load factor can be insured.

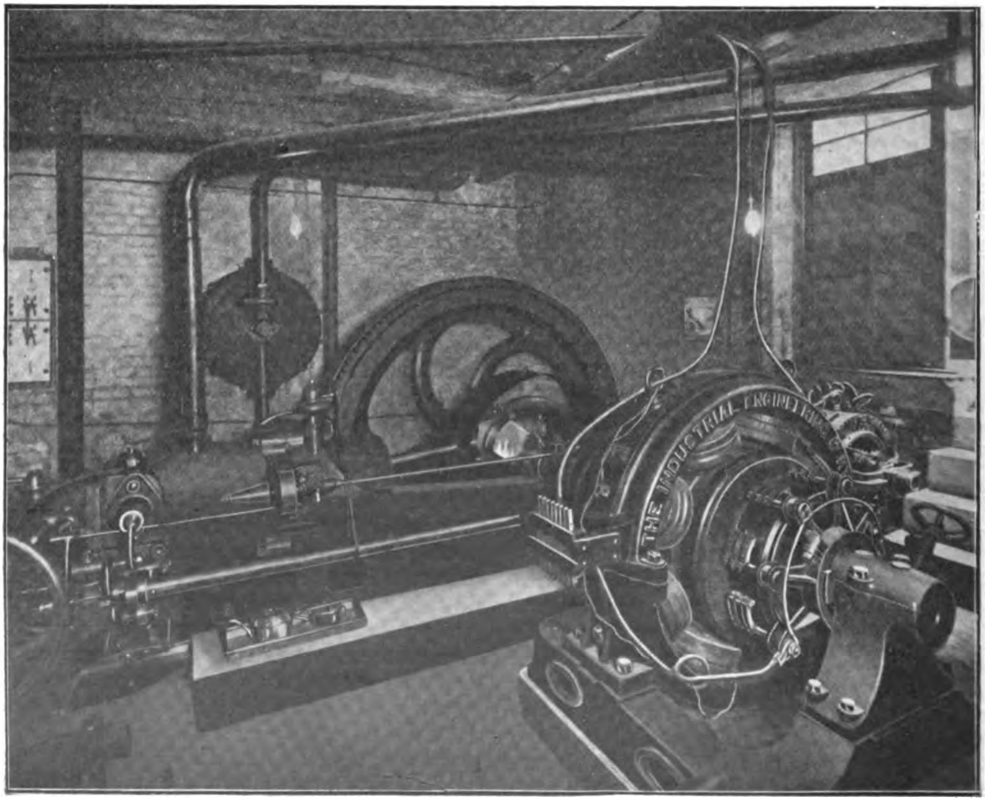
A large installation of suction gas producers and gas-dynamos was put down some months ago by the Industrial Engineering Company at the Holborn Empire, in London. The local conditions were unusually awkward, necessitating the selection of an engine house in the basement, and an upper room for the gas producers. Notwithstanding this unusual arrangement, no difficulty was experienced, and since starting, the plant has continued to run very efficiently, and fulfils all the requirements usually met with in theatre work. The power and lighting load of a theatre varies very considerably; at one moment the plant running practically on light load, and a few moments later at full load, and frequently overloads.

The Industrial Engineering Company also supplied two dynamos each of 35kw., each coupled directly to gas engines running at 200 revolutions per minute. The two gas producers are each capable of developing 75 b.h.p. as a normal load. In the engine room there is also the main switchboard, controlling the principal circuits of the theatre, and there is also an "Industrial" motor generator for boosting the line voltage sufficiently to charge a battery. At the back of the stage there is the usual switchboard controlling all the scenic and auditorium lights. The battery above mentioned supplies the lamps in all the exit passages, so that should fire or any other mishap sever the supply from the engine room, the exit passages will be assured of light.

This installation is only one of a large number of similar plants, working successfully under severe conditions, which have been installed by the Industrial Engineering Company.

Improved Meters for A.C. Currents.

It has now been generally conceded that the only satisfactory meter from the point of view of both suppliers and users of electric current is the watt-hour-meter, usually called the watt-meter. Hitherto the depreciation of the commutator, requiring periodic cleaning, the delicacy of the bearings, sensitiveness to erect position, and especially liability to disturbance from short circuits, have somewhat overshadowed the great advantages of this type of meter. A good meter cannot be made from poor material or antiquated designs, with inaccurate calibration. The Hanby meter, introduced by the Union Electric Co., Ltd., has been designed by experts with a full knowledge of the causes of failure of previous makes and types, the material is throughout the best, and the meter will last and register accurately under conditions



35KW. GAS-DYNAMO OPERATING ON SUCTION GAS.
One of two supplied by the Industrial Engineering Company to the Holborn Empire, London.

where the cheap and flimsily put together type of meter would soon fail. Quality of material, accuracy of workmanship and calibration, durability and efficiency, are the standards of this meter, and for these desiderata it is not difficult to understand that meter users are prepared to pay. Price is not the first but one of many considerations in the purchase of meters; where durability and accuracy are assessed at their true value the cheap meter, like the cheap watch, is not simply the lowest priced article put forward under a name to which it has little real claim.

The meter, which is constructed in two different sizes, registers upon a dial the sum of the electrical energy which has passed through the circuit, whether inductive or non-inductive, and independent of any phase displacement between current and voltage.

The principle embodied is that of a split-phase motor without commutator. A simple metallic disc is placed in a rotating field, created by a series and a shunt winding, so arranged that the torque is proportional to the energy passing through the meter. Fig. 1 shows the hollow cast-iron base-plate looked at from the rear of the meter. Upon this base the following parts are fixed:—A laminated shunt wound magnet and fine wire coils in series with resistance coils, and also a similar magnet wound with a thick main current conductor acting as a yoke. It will be noted that the series winding embraces both sides of the horseshoe shaped core. Dividing these two magnetic parts is an air space, between which projects a light stiff disc, which has its spindle bearings on the other side of the base-plate.

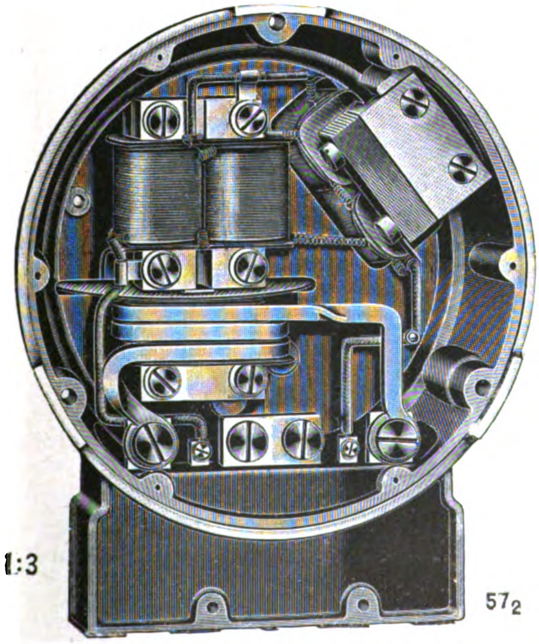


FIG. 1. BACK VIEW OF HANBY METER WITH CASE REMOVED.

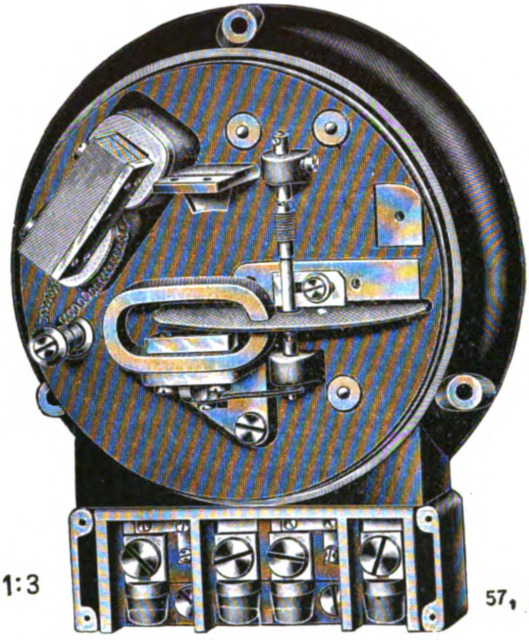


FIG. 2. FRONT VIEW OF HANBY A.C. METER WITH CASE REMOVED.

Fig. 2 shows the front of the base-plate, with the disc rotating between the jaws of a seasoned permanent magnet. The iron base-plate effectively isolates any possible magnetic effect of the current carrying parts from the permanent magnet, so that even in the event of a short circuit it is not in any way affected.

The method of mounting thoroughly protects all the moving parts from shocks and vibration, and it is not necessary to provide any special arrangement for transport. We understand that it is impossible for the meter to run upon no load.

All the current-carrying parts are carefully insulated and the four terminals are entirely surrounded by insulating material. The meter is proof against an a.c. voltage of 1000 or more between the current-carrying parts and the case. The energy required by the shunt circuit is from 1½ to 2 watts, whilst that in the main circuit with full load is from 1.2 to 1.5 watts (*i.e.* total 2.7 to 3.5 watts). The series winding is sufficiently large to carry 30 per cent. overload.

The accuracy is within 3 per cent. from about 5 per cent. of full load up to the full load, and the meter starts with certainty at about 1 per cent. of the full load.

A meter of this type is quite suitable for polyphase circuits with equally loaded phases, provided always that the neutral point is accessible. Under these circumstances the meter is wound for the star voltage, and calibrated so as to indicate the total energy of the polyphase circuit. In the case of polyphase current with equally loaded circuits, in which, however, the neutral point is inaccessible, the pressure winding must be arranged for the delta voltages, and the instrument is calibrated accordingly.

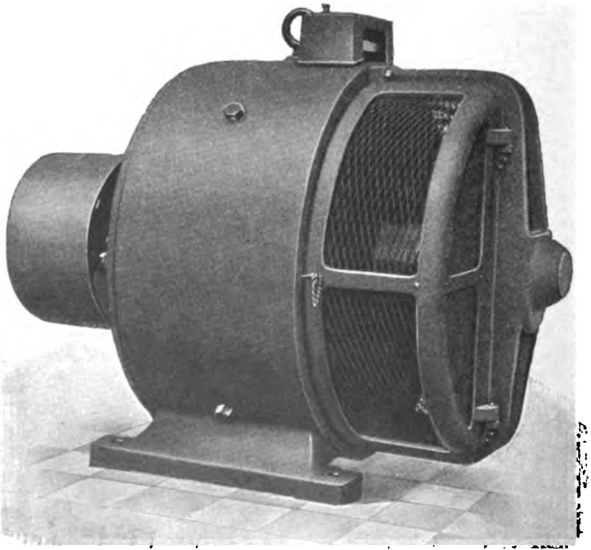
The Hanby meter can be used on voltages up to 500 a.c.; for higher voltages a voltage transformer is necessary. In the same way for currents exceeding 150 amperes, a current transformer is necessary. In such cases the current and voltage transformers give respectively 5 amperes at full load, and 110 volts on the secondary.

J. H. Holmes & Co.'s New Motors.

These are a new line of machines which have been very carefully designed to be up to date in every respect and combine many important features. The design of frame, with laminated, high permeability poles of special shape, is very compact and ensures freedom from vibration even at the highest speeds. Ventilation is very carefully attended to, so that a very free circulation of air in every part is ensured. Great care is taken in the insulation of the windings, ample space being provided everywhere, and the subdivision of the coils preventing any great difference of potential, and permitting of every layer of wire being near the surface of the field coils.

All parts are made to gauge so that spare parts can be obtained at any time. The constants of the design have been carefully chosen so that there is margin enough to allow any of these machines to have a 3 to 1 range of speed by shunt field regulation only and sparkless at the brushes, the highest speed being chosen within the limits of safe running. The first series has a range of 5 to 65 b.h.p. at normal speeds of 675 revs. to 1275 revs., but the range of possible windings with standard commutators gives a series of speeds from 200 revs. upwards. These machines will stand an overload of 100 per cent. for short periods. The machines are also wound as shunt or compound dynamos.

We are informed that the makers are prepared to meet all possible requirements of power users with these motors and will deal with any special cases if full particulars are sent. They will also forward price lists and full specifications on application.



Exterior View of Holmes "Castle" Motor.

Accumulator Ignition.

Until magneto ignition becomes general, recourse must be had to batteries, and these in their turn must be charged. This circumstance detracts somewhat from the simplicity of accumulator ignition, and adds another care to the already formidable list inherited by the motorist. Battery charging is something which must be closely watched, as the life of the cells depends upon its regularity, and so also does the performance of the battery. To be pleasurable, the care of ignition batteries should become automatic, and with a view to making this nearly so, Portable Accumulators, Ltd., of Shaftesbury Avenue, London, and Much Park Street, Coventry, have instituted a system by which they assume the responsibilities of battery charging and maintenance hitherto resting on the motorist. They have arranged to supply motor-car and cycle owners with freshly-charged batteries under conditions which are simplicity in the extreme. A small annual fee is charged, and in return a pass is handed to the subscriber which enables him to receive freshly-charged cells in London and Coventry. The hired cells must be exchanged against fresh ones at least once a month whether exhausted or not, or if the voltage drops below 3.6 volts for each 4-volt battery the exchange must be effected within two days. The batteries must also not be entirely run down or be returned in a sulphated condition. The company undertake to supply the cells in a good and substantial condition, and under the terms specified hold the subscriber responsible for all damage done. Subscribers must also deposit a sum equal to two-thirds of the catalogue price of the battery they are taking, this being retained in case of non-compliance with the conditions of the agreement. Should any subscriber wish to retain the hired battery he can do so by notifying the company beforehand. Subscriptions are not accepted for less than twelve months, and owners of more than one car or cycle can take out two passes, the second carrying a 5 per cent. reduction on the charges made. The fees are 2 guineas for cycles and tricars, 2½ guineas for small cars, and 3 guineas for large cars. The company has kindly supplied us with a gratuitous pass, and we shall report as to the operation of the scheme from time to time.

New Catalogues.

Any of the firms mentioned below will forward the literature reviewed under this heading on receipt of a post-card request for same.

Mining Switches.—Ferranti, Ltd., Hollinwood, Lancs. Catalogue No. 92 gives details and prices of oil break enclosed two and three pole mining switches for alternating currents up to 450 amps. and 1000 volts. We have also received Catalogue No. 95, which is a price list of the firm's supporting brackets for instruments.

Motors.—A.E.G., Charing Cross Road, W.C. A useful publication is to hand from the A.E.G. dealing with motors for intermittent service. The motors treated of are of the series and polyphase types. Several pages of useful introductory matter are included dealing with the application of the motors, their rating and temperature rise, ventilation, &c. The motors are chiefly intended for cranes, machine tools, turntables, rollers, and similar machinery. Information as to the best fields of application of the various types of motors is given, and intending purchasers will find this useful. The three-phase motors are also specially dealt with. The pamphlet is punched for inserting into the file supplied some months ago by the company.

Fans.—The National Telephone Co., Ltd., Salisbury House, London Wall, E.C. A four page leaflet on the company's electric fans which includes descriptions of ceiling, desk, wall, bracket, and lampholder types, for both direct and alternating current.

Castle Motors.—J. H. Holmes and Company, Newcastle-on-Tyne. We have received a printed specification and description of the "Castle" W-Type multipolar d.c. motors and dynamos, and understand that a copy will be forwarded to any enquirer mentioning The Electrical Magazine.

G. E. C. Progress Sheet.—The General Electric Co, Ltd., Queen Victoria Street, E.C. The February Electrical Progress Sheet (No. 63) contains illustrated particulars of prices of "Carsak" Leclanché Cell, battery ringing telephones, "both call" and waterproof telephones, "B.C." bracket fitment, insulated hand lamp, cover for Nernst lamp, and "quadrant" switches. Attached to the sheet is leaflet 0,1105, giving reduced prices of Geeko ignition accumulators. The March Sheet (No. 64) gives details of a new front door push button plate, a new lift indicator cell testing meter, several types of fittings such as switches and ceiling roses, and the "Shadoless" electric candle of which we gave details in our last issue.

Tank Switches.—A. Reyrolle and Co., Ltd., Hebburn-on-Tyne. Pamphlets 25 and 26 will be found interesting by all users of electric power. No. 25 describes, illustrates, and prices the company's three-phase oil-tank switches, which are made for pressures between 400 and 6000 volts and currents between 100 and 400 amps. per phase. Overload automatic releases are fitted to the switches if required. No. 26 pamphlet gives details of a lever type D.P. motor starter and speed regulator. It is very compact, and should fill a decided want with this class of apparatus.

Pyrometers.—Crompton and Co., Ltd., Salisbury House, London Wall, E.C. A very useful article is the electrical pyrometer, and the form manufactured by Crompton & Co., Ltd., will be found both simple and reliable. A full description with photographs and diagrams is given in a special pamphlet issued by the company which will be forwarded on application.

Ignition Batteries.—Portable Accumulators, Ltd., 210, Shaftesbury Avenue, W.C. Every motorist should have a copy of this company's pamphlet No. 6, giving prices and particulars of Pfluger ignition batteries. The pamphlet is produced in attractive style and not the least attractive portion is the price list, which will be found worthy of close perusal in conjunction with the high standard of the cells offered.

Isolated Plants.—J. H. Holmes and Company, Newcastle-on-Tyne. List No. 101 is a carefully compiled booklet tabulating Holmes' country house installations. The motive powers available are discussed in the introductory pages, and advice is tendered as to the most suitable for special circumstances. A number of excellent views of magnificent residences, which have been provided with plants, completes an attractive piece of trade literature.

TRADE NOTES.

Messrs. Ed. Bennis and Co., Ltd., manufacturers of coal elevating and conveying plant and patent gold medal machine stokers, of Little Hulton, Bolton, and 28, Victoria Street, London, S.W., are so busy with contracts in hand and new orders that they are working overtime. The sustained briskness of trade and the demand for increased output necessitates an early extension of their new works. In addition to the contracts secured by this firm which have been already mentioned in the Press, the following orders have been received:—British Cotton and Wool Dyers' Association, Bradford—ten stokers and compressed air furnaces (repeat); Ocean Coal Company, S. Wales—coal elevating plant with six stokers and compressed air furnaces; Glamorgan Coal Co., Ltd., S. Wales—complete coal elevating plant, together with eight stokers and compressed air furnaces; Patent Shaft and Axletree Co., Ltd., Wednesbury—four stokers and compressed air furnaces (repeat); Cardiff Steam Coal Collieries Co., Ltd., Cardiff—four stokers and compressed air furnaces (repeat), complete coal-handling plant; Plas Power Colliery Co., Ltd., Wrexham—four stokers and compressed air furnaces (repeat); African Oil Mills Co., Ltd., Liverpool—two stokers and compressed air furnaces (repeat); Australian Alum Co., Runcorn—two stokers and compressed air furnaces (repeat); Darlington Corporation Elec. Station—two stokers and compressed air furnaces; Storthes Hall Asylum, Kirkburton—two stokers and compressed air furnaces (repeat); Corporation of Worcester Electric Station—two stokers and compressed air furnaces; Spencer and Co., Ltd., Melksham, Wilts—two stokers and compressed air furnaces (repeat); Chilworth Gunpowder Co., Ltd., Chilworth—two stokers and compressed air furnaces; J. M. V. Money-Kent (for Cape Copper Co., Glamorganshire)—one "Bennis" patent ten ton revolving truck tippler similar to the one supplied to the Metropolitan Electric Supply Co., Ltd., Willesden; Societa Siderurgica di Savona, Savona, Italy—two stokers and compressed air furnaces.

Personal.

Mr. T. W. Sheffield, A.M.I.M.E., A.M.I.E.E., who opened (and managed for some four or five years) the Manchester branch of the British Thomson-Houston Co., Ltd., has been appointed manager for Messrs. Crompton and Co., Ltd., to control a larger district, including Lancashire and the North-Western counties. Messrs. Crompton's new showrooms and offices in Manchester are at Woodall's Buildings, 42, Deansgate. We understand that Messrs. Crompton and Co., Ltd., have obtained very successful results in the application of the three-phase system, and they are taking up the question very energetically in connection with the textile industries in Lancashire and Yorkshire. They have also recently completed a very large installation for complete colliery equipment for South Wales. It is officially stated that Messrs. Crompton and Co., Ltd., have supplied over 70,000 of the well-known Crompton arc lamps for different lighting schemes in this country. We understand that they have opened a special department at the Manchester office to deal with the application of electrical driving for mills and workshops.

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Mr. David Alexander, A.M.I.E.E., of 43, Mains Street, Glasgow, has been appointed by the Adams Manufacturing Company, of London, their agent for the sale in Scotland of their patent Sturtevant "Igranic" motor-starting and controlling appliances.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

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The World's Electric Progress.

NOTICE.—*All communications, both of a business and Editorial nature, should be addressed to our Head Office,* 4, *Southampton Row, Holborn, W.C.*

The Great International Number.

BY the time this issue is in the hands of our readers, we shall have practically completed our arrangements for the publication of the special International Issue to which we have constantly referred during the past few months. We think this a fitting occasion upon which to draw attention to the importance to this country of the visit of kindred electrical institutions which has been looked forward to so long, and will now soon be a thing of the past. We have prepared special plans for celebrating this exceptional event, because we consider that its international character requires more than ordinary recognition at our hands. Nothing could be better to promote the welfare of the world's electrical interests than such a gathering as this, and this in itself is sufficient reason to justify our efforts to present both to our ordinary readers and the visiting members a concise and comprehensive record of British electrical enterprise, more particularly in its present-day aspects. We anticipate that the meeting will also have a powerful influence on our trade relations with the countries represented, and electrical and allied manufacturing interests should have this prominently before them. We do not suggest that they *are* missing the opportunity; our experience indicates rather that they are keenly alive to its business value, and are securing publicity in various directions. We ourselves offer unusual facilities in this particular, which are being taken full advantage of by many representative British firms. Our wide colonial circulation is an important factor in these publicity proposals, and we strongly emphasize it here because the organized expansion of colonial trade is a matter of immediate concern to the electrical industry of this country. We do not often appeal to advertisers from the editorial chair, but at this juncture, in view of the very exceptional nature of the occasion, we feel justified in so doing. At the moment of completing the realization of our elaborate plans, we express the hope that those manufacturers who have not already embraced this unique chance of effective and forceful representation will in their own interests co-operate with us to the utmost in making this great International Issue the truly magnificent success we intend it shall become.

* * *

The Circular Tour.

WITHIN a week of the publication of this issue, the distinguished visitors of the various foreign electrical societies to this country will have arrived, and the elaborate programme for their entertainment will at once be entered upon. In a previous issue we intimated the general route of the tour, and now can give some details of the chief places to be visited. Sight-seeing in London will occupy five days, including Sunday, June 24th, and on the Monday following the "business" provided for will be proceeded upon in earnest. The afternoon will include a visit to the National Physical Laboratory, where the Rt. Hon. R. B. Haldane, H.M. Secretary of State for War, will open the new Electro-Technical Laboratories. The evening will be occupied by a reception and banquet at the Hotel Cecil, by invitation of the General Reception Committee and the Institution. Tuesday will be a power-house day, and the visitors will be split up into five groups, which will proceed respectively to see the Postal, Telegraph, and Telephone system and exchanges, the Greenwich power house of the L.C.C., the Bow Station of the Charing Cross, City, and West End Electricity Supply Company, the Lot's Road Power Station, Chelsea, and the plant of the Central London Railway at Shepherd's Bush. Obviously, the entire party could not be conducted over this ground during one day, so the policy of subdivision was resorted to, though we expect with detriment to the load factor. On Wednesday the stress of Tuesday's hustle may be relieved by a Thames trip from Windsor, and this excursion should fortify the party for the provincial tour to commence the following day. Birmingham is just to be "peered into," though in the eight hours allowed much of interest should be seen. An alternative to this is, however, provided in a diversion to Stratford-on-Avon, where "Shakespeare's country" will be rambled over during the day. This party will join the main body at Birmingham the same evening, and the later hours will be spent in travel to Manchester, which is due to be reached at 9 o'clock. The next day, in Cottonopolis, is to include visits to Stuart Street station, the Westinghouse Works, and Ship Canal, luncheon at the Town Hall and Mayoral Reception intervening. In the evening there will be a reception and conversazione at the Victoria University. Saturday, the 30th, is to be Liverpool's day, and by 9.45 a.m. the party will be in that city. Lister Drive station will be visited, also the Liverpool Overhead Railway, the L. and Y. electric railway and power house. The afternoon concludes with a Mayoral Reception and return to Manchester. Sunday is planned for a peep at the English Lakes, the excursion including a drive from Windermere to Keswick by way of Grasmere. Glasgow will be entered the same evening, and Monday and Tuesday have been set aside for works visits, receptions, and conversaziones. One of the latter, arranged for Monday evening, will be presided over by Lord Kelvin at the University. Tuesday's round includes the inspection of the Renfrew Works of Messrs. Babcock & Wilcox. Wednesday is to be passed in Edinburgh, and Thursday will afford the Tynesiders an opportunity of showing their hospitality to the visitors. The Leeds Electricity and Tramways Committees will welcome the party at noon on Friday, and that day and the next will be well occupied in inspection of works in the district. An excursion to lovely Harrogate will bring this admirably planned tour to a close.

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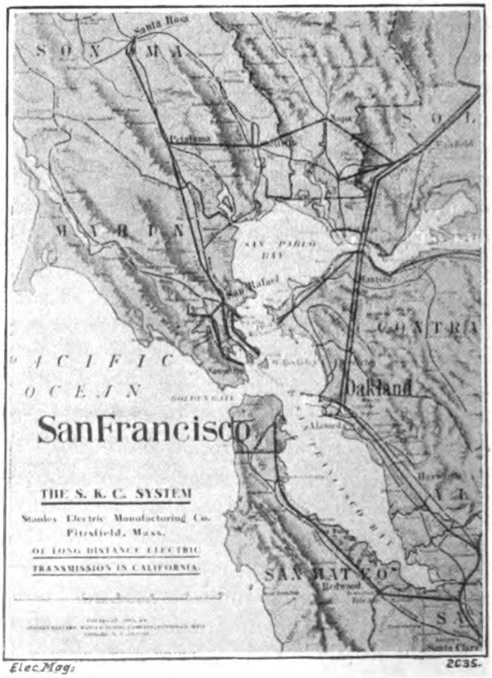
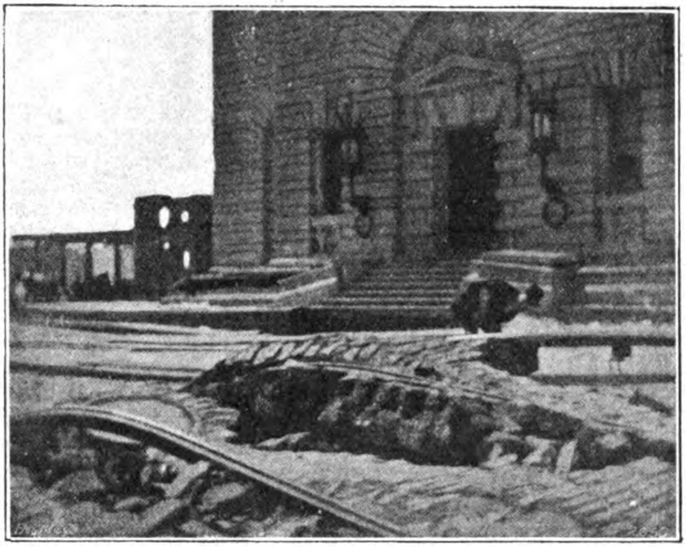
The New San Francisco.

WHEN we commented upon the San Francisco calamity last month the details of the electrical disasters were scanty in the extreme. Now, however, the American technical journals have published news from their correspondents on the spot which throws considerable light on the situation. It appears that most of the quarters of manufacturing concerns were damaged to an



MAP OF THE SAN FRANCISCO DISTRICT, SHOWING CHIEF POWER TRANSMISSION LINES INTO THE CITY.



SCENE IN SAN FRANCISCO STREET AFTER THE EARTHQUAKE, SHOWING ITS EFFECT ON TRAMWAY TRACKS.

extent necessitating the opening of new and temporary offices either among the ruins or in neighbouring towns. Despite the fact that the fire raged for three days the underground cables were found suitable for service, and step-down transformers were hurriedly got into place on the site of the burned sub-stations to feed these cables. The demand for current is hourly increasing, but the electrical agencies were unable for some time to get motors and other machinery into the ruined city by rail because all freight was held up to allow provisions and other necessaries an entry. Building operations are proceeding apace, and it is expected that a heavily reinforced concrete form of structure will be largely used because the steel-stone buildings were stripped of their masonry facings, although the framework remained standing. Amidst the horrors of the earthquake and conflagration the heroism of the telegraph operators is singularly conspicuous, many of these men remaining at the wire while buildings around and under them were tottering and falling. Again in the terrible days following the disaster, ignorant of the whereabouts of their families and without food and water, they stood by the companies employing them without any other incentive than duty. We reproduce a map from the *Western Electrician* showing the power lines around San Francisco and also a view of the street railway tracks after the seismic disturbance. The intense heat of the fire also caused warping, and in some instances the running rails were drawn close together. Where trolley wires were strung the supporting poles were melted and quickly came to the ground. The trolley lines in several places were got running again within ten days of the fire, and where cable cars could not be started a temporary trolley line was erected in three days. Free rides were allowed at first, but fares were collected after four days and the money turned over to the relief committee. Judging by the reports San Francisco will soon be electrified into ordered activity again.

◆

Electric Smelting of Iron and Steel.

THE hopes of electro-metallurgists of ultimately producing iron and steel by some easily applied and admittedly commercial process have run high during the past few years. The development of hydro-electric power stations has encouraged these aspirations by presenting opportunities for exceptionally cheap power, and the problem has resolved itself into a matter of the particular method employed in the furnaces. Mr. R. E. Hadfield, speaking recently before the Institution of Civil Engineers on the subject, was not at all optimistic of success in this direction for some years to come. He contended that many problems yet remained to be solved in the production of steel, and that the processes at present in use, namely, the Bessemer and Siemens-Martin, though refined somewhat in detail, have not undergone any alteration in principle, consequently, in his opinion, they will remain standard for some time. He said that probably over one hundred million tons of coal, or about one-seventh of the world's total output, are used annually in the smelting of iron, quite apart from the enormous quantities employed for working this into steel. He gave it as his opinion that quite apart from the question of a cheap power supply, the electric furnace does not purify steel any more than other furnaces specially adapted for the purpose, and that the old type of crucible steel smelting would remain a strong competitor of the electric process for many years yet. The pronouncement of an expert metallurgist, such as Mr. Hadfield is, must be treated with respect, and although electrical engineers, as a whole, look forward to the more general employment of electric power for the production of metals, they would not be justified in disregarding the views of one whose experience particularly fits him to speak definitely on the subject. On the other hand, there is not the least reason for a pessimistic attitude as the electric furnace possesses many advantages and a degree of flexibility which cannot be obtained by any other known process. Developments of a revolutionary character would probably be detrimental to the progress of electro-metallurgy, and, judging by similar movements in other spheres of industry, the aim in view will be best attained by a gradual expansion of present methods until their more general adoption gives them a prominence which will justify the abandonment of the older processes.

❧

Steam Building Cranes.

IT is high time that steam derricks disappeared from the scene of building operations in our great cities and provincial towns. Perched high above the foundations on which some fine new offices or business premises are rising, the steam crane with its boiler and furnace is a menace to workmen and passers-by alike, and should be condemned as such without further delay. When electric power mains are lying in the street outside there is no sense in hoisting up a boiler and steam engine to a staging one or two hundred feet high simply for the purpose of handling heavy material around the works. A motor-driven hoist will be half the weight and infinitely easier to get up to the stage, and we are at a loss to understand why steam engines are allowed by the district building authority. The chief danger to the workmen lies in the use of fire on a flimsy structure of wood which might easily become ignited and would be difficult to put out. Considerable damage and harm to adjoining buildings and passers-by would also be done should the boiler explode or the crane accidentally topple from its lofty perch. This is not by any means an uncommon occurrence, and fatalities have always resulted as a consequence of the mishap. The electric crane presents none of these risks, and where conditions are favourable, that is where a power supply can readily be tapped, its use should be rigorously enforced. In London particularly we have noticed that electric cranes for building operations on extensive sites are in the minority. We have always felt that the hoisting of a boiler skywards to the derrick staging should be an object-lesson to the power supply company or borough council in the district, and in view of the immense possibilities of accident with steam apparatus any such proceeding is a standing disgrace to the engineer in charge. This may appear to be a sweeping indictment, but we think that the circumstances of the case fully merit it. Electrical hoisting appliances are now standardized, and the fitting of them and their employment in the particular field mentioned presents no engineering difficulties. It is simply a matter for enterprise and "push" on the part of the power-supply authorities.

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POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

The Coming Power.

By E. R. KNOWLES.

THE constant endeavour at all times has been, and is, to produce power at the lowest cost, and countless methods for so doing have been devised. Natural forces, such as the wind, the heat of the sun, the flow of water and the tides have been utilized with more or less success, but these forces are either too inconstant and irregular in their action or are not widespread enough for general use. The combustion of various substances, as fuel and the utilization of the heat thus generated, appears to be the most satisfactory source of power, and the greater portion of the efforts to produce power cheaply have been directed to various methods of heat application.

The most popular form of such heat application and the one that has been up to recent times carried to the greatest point of refinement is the steam plant, in which the heat of the fuel is utilized to heat water, turning it into steam, and the steam in turn used to operate an engine constructed for that purpose. But even in the most carefully constructed and operated steam plants the efficiency of conversion of the heat into power is extremely low.

When it is considered that a pound of coal has an average of about 13,500 thermal units and that under the very best conditions in the most modern of steam plants about 12,500 thermal units or about ninety-two per cent. are lost on obtaining the useful effect of the remaining ·1000 units, and that this ratio is even greater in the average steam plant, it will be realized how great this loss is.

The illustrations Figs. 1 and 2 show diagrammatically the ways in which this energy goes to waste in a steam plant.

The *ultima Thule* of all investigators in this line of work is the direct production of power from the fuel itself, but this to-be-hoped-for method has not as yet been discovered. The nearest approach to this ideal condition is the internal combustion engine, a form of engine in which the fuel is burned in the cylinder and there acts directly on the piston to produce power.

While cheap fuels, such as gasoline, fuel oil and natural and illuminating gas have given the internal combustion engine a rapid and unusual precedence over all other forms of engines, it is still necessary, in order to make its use as universal as possible, to have a fuel which can be obtained at any desired point, independently of any natural source or of any fixed point of manufacture and distribution, and one which can be made from the cheapest material which can be obtained and utilized.

Such requirements have resulted in the introduction of the gas producer and what is commonly known as producer gas, undoubtedly the cheapest and most economical fuel in general use at the present time.

Fig. 3 gives in diagrammatic form the ways in which the energy in a gas engine producer system is dissipated and the amount of useful effect obtained. It will be seen that while the losses of energy

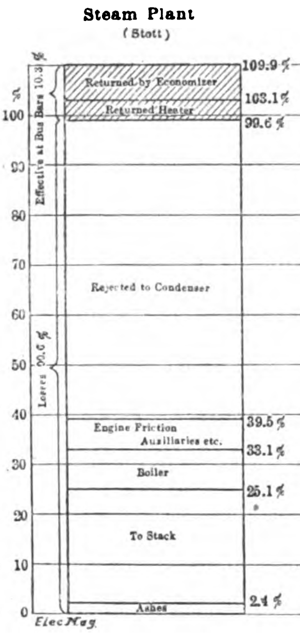

FIG. 1

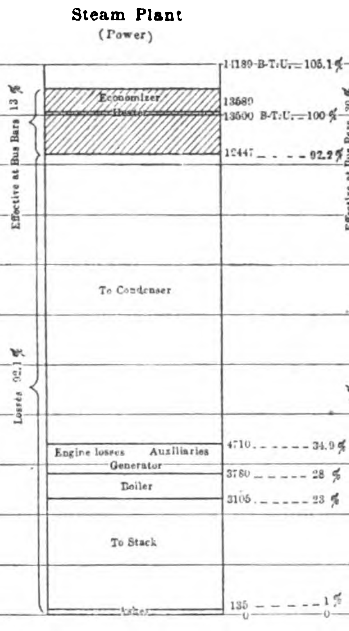

FIG. 2

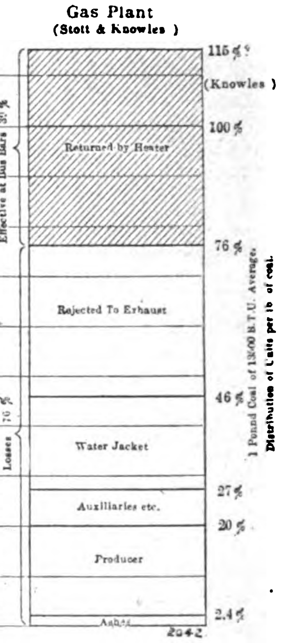

FIG. 3

are still large, the percentage of useful effect has been greatly increased, and that it is possible by this combination to secure as high, possibly, as thirty per cent. effective return at the point of power application.

It has been stated by Mr. C. E. Sargent, of Chicago, that from recent investigations made by him, power generated by the gas engine producer system may be as much as ten to fifteen per cent. lower in cost than hydraulic power.

In the gas engine producer system we have a source of power production that is almost universally adaptable to all conditions of environment and application, which is the cheapest in cost of any power production known at the present time, is simple and compact in arrangement, is the most efficient, is safe, is sanitary, has a low cost of maintenance and repairs, calls for a minimum of attendance and attention, requires no licensed labour, is always available and ready for use, and is in every way more nearly fitted for universal application for power purposes than any other source of power production known at the present time. These qualities render the gas engine producer system especially valuable not only for future power applications, but also as a substitute for present power installations which are now operated by steam or other forms of power.

This system of power generation is not only as fully applicable to all purposes where power is required as is the steam engine, but is really more so, for while it can do all that the steam engine can do, it can be more universally applied.

While the gas engine producer system is still far from the desired ideal system, nevertheless the great gains in efficiency and lowering of cost production shown by this system and its many advantages are such that with its advent the gas engine has made such rapid strides as a prime mover, and its adoption to power generation has given so much satisfaction, not only from an economical point of view, but also for continuous and hard service, that it bids fair to revolutionise all present methods of power production and to become the legitimate successor of the steam engine and steam system.—*Electrical Review*, *N. Y.*

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Niagara Power in Ontario.

THE Province of Ontario, Canada, is naturally concerned with the economic distribution of electric power from Niagara Falls, and to secure the most effective system a Hydro-Electric Power Commission was appointed to inquire fully into the facts of the case. The first report of this body has just been published, and we think its deductions sufficiently important to abstract at some length. The Commissioners were authorized to report upon the following matters:—

The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different water-powers within the jurisdiction of the Province of Ontario. The location, capacity, and capital cost of development of the various water-powers at present undeveloped. To ascertain the rates or prices that would require to be charged the various classes of consumers of hydraulic or electric power. To inquire into and ascertain the annual savings accruing to the consumers by the substitution of the new rates for those paid at present. To ascertain the cash capital cost of the hydraulic and electrical undertakings of existing companies located within the Province of Ontario. In this first report the Commissioners deal only with that part of South-Western Ontario which, roughly speaking, lies south of the latitude of Toronto, but including Toronto, and which may be called the Niagara district.

In order to ascertain the probable market the Commissioners caused inquiries to be made in the various manufacturing centres in the district, with the following results: They are satisfied that a market for at least 50,000h.p. could be obtained within a reasonable radius of Niagara Falls as soon as transmission lines can be constructed, and this could be increased to at least 100,000h.p. within five years thereafter.

The following table (I.) shows the cost of distribution from municipal sub-station to an individual consumer, not covered by local distribution.

The table below (II.) shows capital costs of steam plants installed and annual costs of power per brake horse-power.

TABLE I.

Distance in miles from Municipal sub-station.	Cost per horse-power per annum for the delivery of various amounts of power.							
	50 h.p.	75 h.p.	100 h.p.	150 h.p.	200 h.p.	250 h.p.	300 h.p.	
5	$8.87	$7.18	$5.98	$4.96	$4.55	$4.32	$4.17	2200 Volts.
6	10.20	8.24	6.77	5.38	5.13	4.60	4.43	
8	14.10	10.14	8.40	6.97	6.24	5.79	5.58	11,000 Volts.
10	16.12	12.13	9.54	8.31	7.68	6.96	6.17	
12	18.76	14.03	11.12	10.22	8.42	7.96	7.22	16,500 Volts.
15	22.74	17.08	13.48	10.89	9.35	8.84	8.32	

TABLE II.

Size of Plant. h.p.	Capital Cost of Plant per h.p. Installed.			Annual Cost of 10-hour Power per b.h.p.	Annual Cost of 24-hour Power per b.h.p.
	Engines, Boilers, &c., Installed.	Buildings.	Total.		
300	$55.20	$18.00	$73.20	$25.77	$46.32
400	51.50	16.00	67.50	24.18	43.61
500	49.40	14.00	63.40	23.19	42.03
750	46.80	13.00	59.70	22.88	41.56
1000	44.30	12.00	56.80	22.47	41.11

Engines: Compound, Corliss, condensing.
Boilers: Water-tube with reserve capacity.

Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labour and fuel (coal at $4 per ton). Brake horse-power is the mechanical power at engine shaft.

In order to institute a comparison between the cost of electric power as has just been set forth, and the cost of power generated by steam or producer gas, the following tables have been compiled after a careful study of data available in technical journals and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The tables represent average working conditions, and assume a high-class installation.

It will be noted that for a consumer requiring a large installation, operating for ten hours only, there appears to be little advantage to be derived from the use of transmitted electric power, provided the power is not to be distributed throughout a consumer's buildings by a complicated system of shafting, belts, &c. But in the majority of cases this condition obtains, and herein lies one of the specific advantages of electric power. Motors can be installed on each floor of a factory, or even on each machine, with but little loss in efficiency, and only such motors as are required to drive the machinery in use from time to time need to be operated. In many cases due to this fact the total electric power consumption of a large factory would be reduced from 25 per cent. to 50 per cent. below that which is required under steam operation, working from a central station.

Again, where electric power is available throughout the 24 hours, many industries will work night and day, thereby effecting a great economy, as is evidenced by a comparison of the cost of 24-hour steam or producer gas power with 24-hour electric power.

Perhaps the most striking advantage to be derived from the use of electric power as compared with other power is that the small consumer can obtain power at a rate which should not be appreciably greater than that made to the large consumer, although the present practice in selling electric power is to discriminate against the small consumer for the reason that electric power prices made by private companies are not based on cost of service, but are merely made with a view to displacing steam.

Table Showing Capital Costs of Producer Gas Plants Installed, and Annual Costs of Power per Brake Horse-power.

Size of Plant, .p.	Capital Cost of Plant per h.p. Installed.			Annual Cost of 10-hour Power per b.h.p.	Annual Cost of 24-hour Power per b.h.p.
	Machinery, &c.	Buildings.	Total.		
10	$137.00	$40.00	$177.00	$53.48	$90.02
30	93.00	33.00	126.00	38.73	65.99
50	80.00	26.00	106.00	32.27	55.22
80	78.20	22.00	100.20	28.70	48.95
100	77.50	20.00	97.50	27.05	45.40
200	74.00	17.00	91.00	24.95	41.78
400	71 50	14.00	85.50	23.41	39.03
500	70.00	12.00	82.00	22.54	37.54
750	67.50	10.00	77.50	21.55	35.99
1000	65.00	8.00	73.00	20.46	34.66

Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labour and fuel. (Bituminous coal at $4.00 and anthracite coal at $5.00 per ton.)

A reference to the table below will show that the cost of power developed by producer-gas plants and gas engines is less than that produced by steam plants of the same capacity. It may be said, however, that up to the present no very large installations of suction producers have been made, 250 to 300 horse-power being about the maximum. But this has been provided for in the table by assuming that the larger plants will be made up of several units, each unit being not greater than 350h.p. capacity. While operation of producer-gas plants has not been going on many years, and complete knowledge on the subject is not available, with the information at hand it is believed that in many situations this form of power producer will be found more economical than a steam plant, and therefore a closer competitor of hydro-electric power. It must be remembered that the same objections hold against the producer-gas plant as those which have been mentioned in reference to steam plants, namely, that 24-hour power costs proportionately more than 10-hour power; that the small consumer does not have the great advantage obtainable by the use of electric power; and also that a central installation in a factory is all that is possible if electric motors are required in various parts of the factory, and the only prime mover available is steam or gas. This will make the cost of electric factory operation very expensive, and considerably higher than the power costs shown in the table. Speaking generally, however, it may be said that producer-gas plants have a bright future, and as the design and construction are perfected, undoubtedly the capital cost will be reduced and the cost of power lessened.

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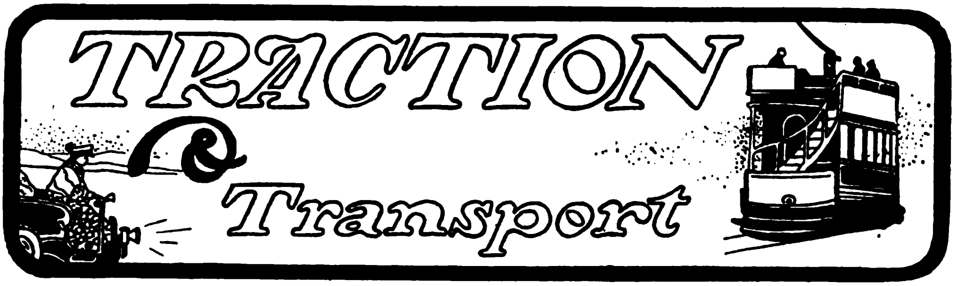


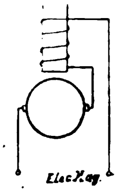
TRACTION & Transport

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

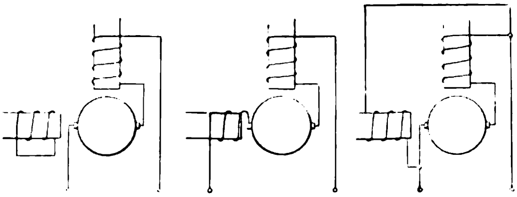
Main-line Electric Railroading.

THE diversity of opinions expressed among electrical engineers as to the future of main-line electric railways is apt to lead to considerable misunderstanding. There are pessimists who consider that the thing never will be accomplished, because the steam locomotive will be improved to a point beyond the reach of competition by electricity, or that it is impossible on grounds of capital expenditure. Again, there are optimists willing enough to go to the utmost extreme of prophetic utterance, and who foresee wholesale electrification of our railways in the next decade. While it is difficult to approve the views of either of these extremists, considerable importance attaches to the problem they condemn or applaud, and due recognition must be given to the attempts at its solution, of which there are many and excellent in different centres of engineering activity. A review of a certain aspect of this important problem accordingly makes good reading, and we are pleased to note that Mr. Philip Dawson has presented our American cousins with a very complete account of the electric-railroad situation in Europe, and which will come as a surprise to many of them. The *Street Railway Journal*, which publishes this review, remarks editorially that "it indicates very clearly that in the electrification of the larger railways our foreign confrères are well to the front, and are less hampered by conservatism than we are." This is certainly a concession from the land of electric-railroad booming.

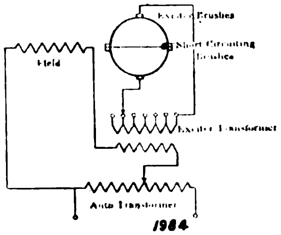
Turning to Mr. Dawson's article, he deals at the outset with the chief reasons for the electrification of present steam lines. He says: "Among the principal causes which may eventually force electrification to be adopted by railways is the very serious competition which they are suffering at the hands of the electric tramways. The railway companies are slowly discovering that although costly opposition may for a time put off the evil day, they cannot stop the progress of and prevent electric tramways and light railways being built. They appear to be at last realizing that the only way to compensate for losses caused by paralleling electric tramways is to improve



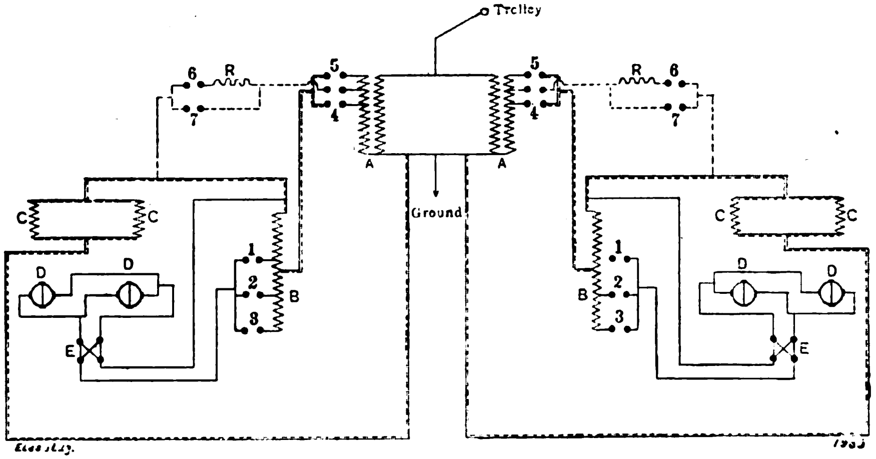
SIMPLE SERIES MOTOR.



THREE FORMS OF COMPENSATED SERIES MOTOR.



EICHBERG-WINTER COMPENSATED REPULSION MOTOR.



EICHBERG-WINTER EQUIPMENT FOR LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

A Main Transformer.
B Exciting Transformer.
C Stator Winding.
D Rotor Winding.
E Reversing Switch.
1, 2, 3, 4, 5, Contactors.
R Resistance.

Position of Controller.	Contractors Closed.
I.	4 — 2
II.	4 — 3
III.	5 — 1
IV.	5 — 2
V.	5 — 3

First braking position 6 is closed. Second braking position 7 is closed.

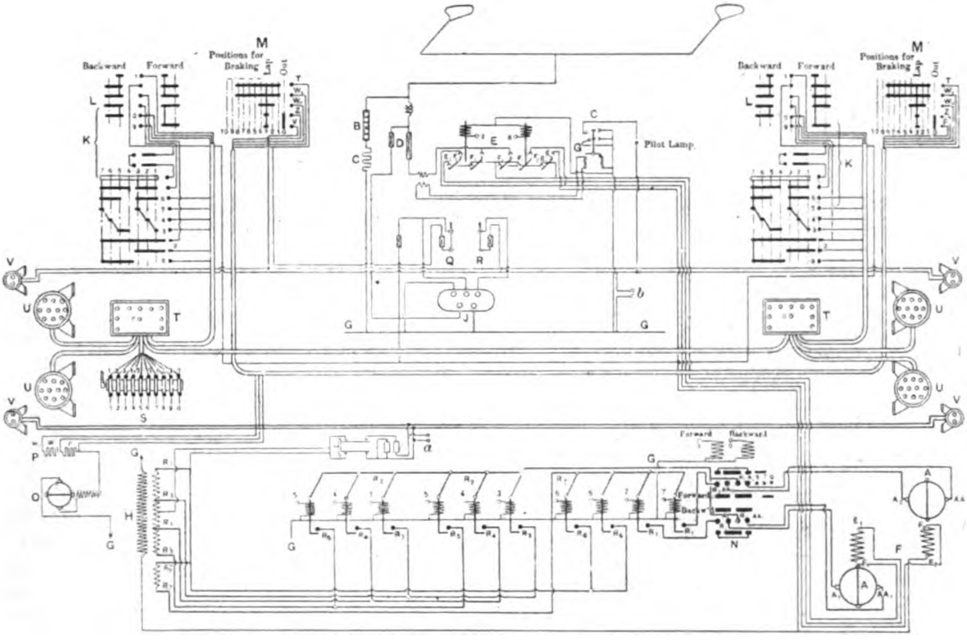
the local service of their own lines, and this, as long as steam is the motive power, is practically impossible. The accommodation at the stations and the number of tracks available are scarcely sufficient to cope with the present services. The great improvement in long-distance services increases the demand on the resources of the railway companies, and it becomes impossible to increase the number or speed of the trains which are purely serving suburban districts as long as these are operated by steam. Furthermore, the requirements of suburban districts are constantly increasing, owing to the very rapid growth of the population in the large manufacturing centres of Europe." Mr. Dawson then backs up his argument by numerous traffic tables which show the enormous increase in the number of the travelling public during the past few years.

He follows this with technical comparisons of the systems suggested, and sets aside both direct and polyphase currents as commercially unsuitable, subsequently giving his unqualified support to one-phase working. Considering the commercial types of one-phase commutator motors, he prefers the Eichberg-Winter form as the most suitable, because high-voltage current can be applied directly to the stator. Connections of various motors and of this last-mentioned form were given, and are here reproduced.

Mr. Dawson's arguments are advanced mainly in support of suburban motor-car trains operated by one-phase currents, and in comparing the acceleration of the Hamburg equipments with an equivalent train supplied with direct current, it is stated that with the latter a speed of 34 m.p.h. was attained in 44.11 seconds, but with one-phase 34½ m.p.h. was reached in 32.11 seconds. Concluding his admirable survey, Mr. Dawson says: "A careful survey of the present traffic conditions existing in and around our large towns clearly shows that the suburban railway systems must be operated electrically within the next few years, and the fact that one of the principal English railways having termini in London, after most careful consideration, has finally decided to electrify its suburban system, upholds this view. Besides the disadvantages of the third rail, and the greater costliness of direct current as compared with single-phase current, this latter presents so many advantages that it would appear to be the only system which, with our present knowledge, will fill nearly all the requirements of railway men, and is, therefore, the most suitable for handling the suburban traffic of our main-line railways."

The Swedish One-phase Experiments.

THE Swedish Government has not allotted £23,000 for one-phase railway experiments with the idea of accepting anything put before its representatives. We have given details already of the locomotives under trial, and it may be well at this juncture to present our readers with diagrams of connections of two systems which will repay close study. Up to the present commutator-type motors are fitted to the trial machines, but we understand that the Oerlikon Company have been invited by the Swedish Government to enter the experimental lists with their Ward-Leonard locomotive, fully described by Mr. W. M. Mordey in this journal two years ago.



A	**Rotor of motors.**
B	**Lightning arrester**
C	**Lightning resistance.**
D	**Fuse**
E	**High tension switch.**
F	**Stator of motors.**
G	**Ground**
H	**Controlling transformer**
J	**Transformer for light, compressor and controlling circuits.**
K	**Master controller.**
L	**Reversing cylinder.**
M	**Brake cylinder.**
N	**Reversing switch.**
O	**Motor air compressor.**
P	**Resistance for same.**
Q	**Pump switch.**
R	**Light switch.**
S	**Car switch board.**
T	**Junction box**
U	**Coupling for controlling circuits.**
V	**Coupler for lighting, pump and heating circuits**
a	**Heater switch.**
b	**Light switch.**
c	**Pilot lamp circuit.**

Elec Mag 1998.

FIG. 1. DIAGRAM OF CONNECTIONS OF EICHBERG-WINTER MOTORS FOR MULTIPLE-UNIT TRAIN.

It will be remembered that locomotives and a multiple-unit train were included in the experiments, the idea being to provide for suburban and interurban service. Fig. 1 is a diagram of the connections for a motor-car equipped by the A.E.G. with Eichberg-Winter motors, and arranged so that the stators of the motors receive the full trolley voltage. The rotors of the motors, with their short-circuiting coils, are shown at A, and the stators at F. High-tension current enters from the trolley-wire, and passes through the change-over switch E, operated by the electro-magnetic switches 2 and 8. Developed diagrams at the right of the illustration show that the stators are first connected in series, and when notch 4 is reached parallel connection is entered upon. The other ends of the stator circuits are coupled to earth through a special controlling transformer shown on the diagram at H. From the secondary of this transformer the rotors are supplied, and to produce a variation in the torque, taps are taken from the secondary, as shown on the diagram. In addition to the brushes leading in this current there is another set which are short-circuited and which carry currents induced in the rotor by the stator, and, reacting upon it, tend to introduce resistance into the stator circuit. The multiple-unit switches are electro-mag-

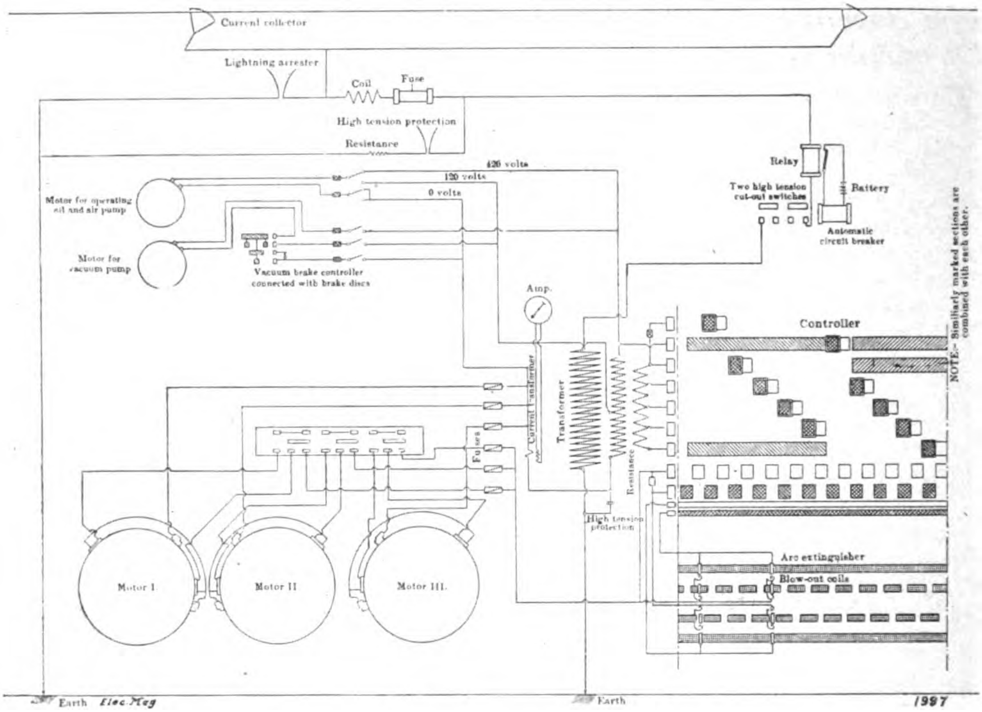


FIG. 2. DIAGRAM OF CONNECTIONS OF SIEMENS-SCHUKERT MOTORS FOR SWISS LOCOMOTIVE.

netically actuated, and receive energy from the alternate-current leads. Fig. 2, which with the preceding figure is taken from the *Street Railway Journal*, is a diagram of the connections of the Siemens-Schukert locomotive being experimented with, and of which we gave an illustration in our January issue. In this case three motors make up the tractive equipment, and voltage control with a single controller is provided.

When the reports of these highly interesting trials are made public they should prove very interesting reading.

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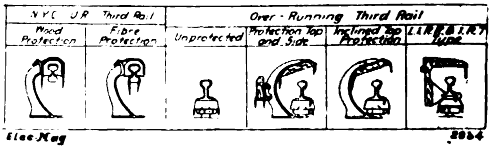
Sleet and the Third Rail.

WITH the early forms of third rail, sleet was a frequent cause of holding up the service, and this in the face of the most carefully planned precautions. The introduction of various forms of protected rail, and also of the under-running form of rail, has somewhat improved the conditions of operation. Investigations were recently made, during the cold weather, in the neighbourhood of New York, on the effect of sleet on the various forms of third rail in use. A very low temperature with slight rain and hail caused the formation of sleet to a depth of ¼in. on the rail. Trial runs with a locomotive were made over lengths of track fitted with the different types of rail, these including exposed, partly protected, and totally protected over-running types, and wood and fibre protected under-running types. With all the over-running rails arcing more or less severe occurred according to the protection afforded; but with the under-running form no trouble at all was experienced. The sleet hung in long icicles at each side of the rail, but the running surface was in no case touched, so that arcing troubles were easily avoided. The adjoining illustration graphically compares the effects of the sleet on the different rails experimented with.



END VIEWS OF VARIOUS THIRD RAILS SHOWING THE EFFECT OF SLEET ON EACH.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

The Care of Brush Arc Lighter Commutators.

By C. M. GREEN.

THE number of Brush arc generators now in use and the importance of the condition of the commutator to the operation of this machine make new and better methods in the care of the commutator well worth attention. The present style of three-finger pressure and two thin leaf brushes used together as one brush has a much lighter bearing against the commutator, and consequently wears it less, giving at the same time a better contact than the old solid three-finger type. If, then, the commutator receives attention for a few minutes each day just before the generator is shut down, it will wear till the copper tips of the wood blocks are almost worn through, the best record being, so far as known, three years and six weeks without renewal, and sixty-three days at ten hours a day without resetting the brushes. However, when new wood blocks or insulating segments are necessary, they are sometimes too high, owing to the worn condition of the copper segments.

The segments may be taken down in the following manner: First, remove the brushes; see that the cover is on the regulator to keep out the dust, put over the regulator and rheostat a cover of carriage cloth, a similar cover being provided for the operator. A flat wood rasp should be taken, and one end held firmly against the brush-holder stud, while the other is brought down until it makes a light cut, only the high parts being touched till the entire ring is cut to a uniform diameter. All of the rings should have finally the same diameter.

Wrap a piece of No. 3 flint paper about a piece of hard wood 16in. by $1\frac{3}{4}$in. square. If the commutator has four rings, use sheets 16in. by 9in., while if it has three rings use sheets 11in. by 9in. Working in succession all sides of the block and moving it lengthwise will use up economically the entire sheet. Pressure on the ends of the stick should be equal, else the rings will be cut unequally; also the entire number of rings on the commutator should be sandpapered at the same time, except when removing the wire edges, at the finish. To disregard these points is likely to ruin the segments and blocks. Next, test all the segments and blocks carefully with a straight-edge to see if they line up. Finish the commutator with No. 2-0 flint paper. Finally spread a little oil across the flint paper that you have been using and apply it to the commutator; it will remove the particles of dust, giving sufficient lubrication and polish.

The commutator of a machine in commercial use should be put in first-class condition at the end of each run, as soon as the current is shut off. A piece of No. 2-0 flint paper wrapped about a stick, as previously described, should be applied to the commutator until the rings are bright and smooth. The brushes need not be removed. The machine should be cleaned immediately after it is stopped, since five minutes at that time will give better results than half an hour when the machine is cold. The polarity of the Brush arc generator is readily seen by the sparks, the negative spark having a zigzag centre, while the positive spark has a straight centre. The negative spark should be horizontal on the brush.

The brush-holders must line up to a straight-edge and their edges must be parallel to the centre line of the commutator, and the bearing surfaces of all the brush-holders must give the same angle with the commutator when tested with a gauge as shown in the diagram, Fig. 1.

Line up the brush-holders, using a wood block and hammer, if necessary. Remove the clamps, placing them so that each may readily be returned to the brush-holder from which it came. (These are not interchangeable.) Place the stud gauge on one of the inner brush-holders, sliding it along until it touches the commutator; turn the brush-holder stud till the gauge shows the slant of the brush-holder to be correct; move the rocker till the end of the gauge is even with the edge of a segment on the commutator, then clamp the rocker. Turn the other brush-holder stud till the gauge, sliding on the inner brush-holder, rests on the commutator, when the end of the gauge should reach to the edge of a break in the commutator 90deg. from its former position. Change the position of the arm if necessary with a hammer and wood block. Then adjust the studs parallel to the commutator by packing the shoulders of them with mica if necessary, or turning the mica washers, using the stud gauge on the inner and outer brush-holders. As the gauge slides along the brush-holder it should meet and fit the commutator exactly, the mark being at the edge of the brush-holder. Also examine the slant with respect to the commutator (by means of the gauge) of each brush-holder when the commutator and brush-holder are parallel, correcting them by packing mica beneath them so that they will all slant the same (Fig. 2). The brushes should be so arranged that the ends of the thin leaf brushes reach to the ends of the three-finger pressure brush, yet do not overlap. The brushes should line up with the segments in an axial direction and should not overhang.

In setting the brushes, commence with the inner pair and set one brush $5\frac{5}{16}$in. from the holder to the tip of the brush, then rotate the rocker or armature until the tip of the brush is exactly in line with the end of a copper segment. The other brush should be set on the corresponding segment 90deg. removed (the same relative position on the next segment forward), but if the length of the brush from the holder is less than $5\frac{5}{16}$in. move both brushes forward until the length of the shorter one from the holder is $5\frac{5}{16}$in. Now set the two outer brushes in the same manner, clamping them firmly in position, and by using a straight-edge or steel rule all the brushes may be set in exactly the same line and firmly secured. If the spark on one of the brushes is a trifle longer than the others, move the brush forward a little so as to make the sparks all of the same length at full load. Equality of the spark lengths is desirable, but not absolutely essential; it gives at a glance an indication of the running condition of the machine.—Abstracted from *Electrical World*.

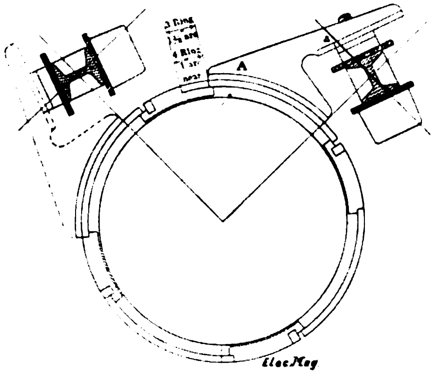


FIG. 1.

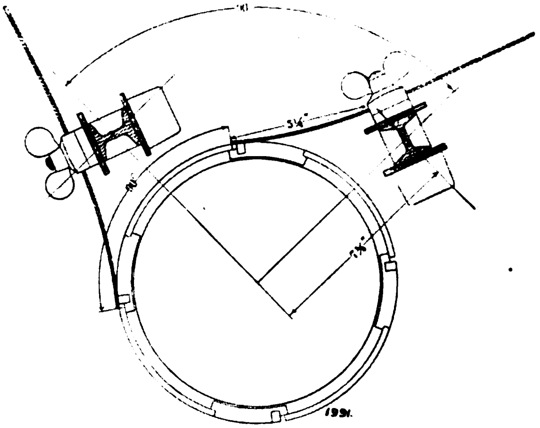


FIG. 2.

Notes on Electrolysis.

THE fundamental principle and primary source of electrolytic corrosion of metallic structures is that, when a current of electricity leaves the unprotected surface of any metallic subterranean construction to pass from it into the earth, the current will electrically disintegrate the metal of the structure. Electrolytic corrosion is an electrochemical effect, for if the electrolytes were not present in the soil adjacent to the pipes, the electric currents could not injure the mains in the least. It is the combination of the electric earth currents acting upon the electrolytes that is wholly accountable for the ravages of electrolytic deterioration upon the various sub-surface metallic structures, by liberating upon their metallic surfaces the dissociated electrolytes comprising acid-forming radicals and nascent gases.

During the summer of 1904, in the city of Detroit, Mich., many experimental tests were made in order to demonstrate how near the law [of electrochemical equivalents] was correct when applied to the electrodes, and from a practical standpoint as well, receiving the following results:—For 500 hours there was passed from the surface of bare wrought-iron structures buried in the natural earth a direct current flow of 5.9 amperes, and since there are 453.6 grams in 1lb., the following equation was received: $1.04 \times 500 \times 5.9 \div 453.6 = 6.79$lb. of iron lost. The loss of 6.79lb. of iron is the calculated deterioration, according to the law of electrochemical equivalents, after being multiplied by the ampere-hours. But the actual loss in pounds of iron after weighing was found to be 67.5lb. of iron, so that the difference of 0.04lb. of iron proved conclusively and decisively that the practical test was correct, within 0.016 per cent. of the law. Practical experiences, in thousands of cases, have proven to my entire satisfaction that a current flow of one ampere passing from the unprotected surface of an iron structure will remove about 20lb. of iron per year from it, or about 72lb. if the structure be lead. Naked cast-iron obeys the same law within a few per cent. of wrought and steel structures, the retardation being due to the electronegative elements of carbon, silica, &c., so commonly found in cast-iron.

The chemical by-products of the electrochemical changes from electrolytic dissociation upon iron and lead sub-surface structures invariably increase the deteriorating effect, producing further and greater injury than the primary evil of electrolysis alone could accomplish. Another peculiar chemical condition is that, when uncoated iron pipes are highly negative to earth, an alkaline substance forms upon their surfaces which, electrolytically, is uninjurious so long as the current remains of the same electrical polarity. If two dissimilar metallic bodies were buried within a few feet of each other, and then only separated by the earth, they would tend to establish a galvanic battery within themselves, corroding the surface of either one or the other. But when the unlike metals form a part of any piping system, such as lead calking, lead service pipes, brass cocks, and the like, in a cast-iron piping line, no ill results could possibly occur. The electrical condition caused by two unlike metals, which are separated by the earth, for example, or any other partial solution containing an electrolyte, is termed the counter-electromotive force of electrical polarization. But since the tracks, and practically all piping lines, as a whole, are iron in some composite state, the current flow from the rails to the pipes has no electrical impediment to overcome, so that the most minute current flow will produce an appreciable damage.

The statement has been repeatedly made that it requires a difference of electrical potential of 1.5 volts between pipe and earth to produce electrolytic corrosion upon the pipes. The writer has personally taken up at least 60 miles of cast-iron mains, and tens of thousands of wrought-iron service pipes, which were completely destroyed by electrolysis when the iron pipes were less than 0.2 of a volt electrically positive to the surrounding earth. It might be well to herein note that the practice of electric street railway companies, during the winter months, of using large quantities of salt upon their tracks to prevent the accumulation of ice, also increases electrolytic action upon the divers sub-surface metallic structures.

Electrolytic deterioration upon bare sub-surface metallic structures is generally more uniformly distributed than upon those having painted or coated surfaces. The pitting effect so universally found upon the exterior surface of all classes of deteriorated lead and iron piping lines is the contributory damage resulting directly from a greater current density or flow of electricity from the pipes at these specific places or spots. The pits occur by reason of the surface of the metallic body having an un-uniform electrical contact with the immediate and surrounding soil, thus establishing many paths of egress for the current. By the excess of current leaving at these exits it electrolytically takes the metal from the pipes and leaves a pit in its wake.

It has been thoroughly known for many years that certain surface waters, especially the surface waters which flow from wooded districts, have a slight chemical acid reaction, and if wrought-iron, steel, and many times cast-iron, are not protected by some indissociable paint or covering, tuberculization of the metal will take place.

Cast-iron, when corroded by electrolysis, leaves a light concrete formation as a residual that has no tensile strength, and which often deceives the observer, since the pits and holes are left well filled with a soft carboniferous matter. All other things remaining equal, cast-iron will withstand a less amount of electrolytic deterioration per given area and cross-section than steel or wrought-iron.

Shunting of the current over the calked pipe joints, as it flows along the line of main, is many times a serious electrical condition, but the extent of the injury is local and distinct, and exceptionally so where the current volume is normal and not augmented by connecting to it negative return pipe feeders. When the current flow is abruptly broken, or the electrical continuity of the mains seriously intercepted by the occasional or random installation of insulated pipe joints, cement joints, or defective electrical calking, then the damage can be and has been acute, by shunting the accumulated current from the mains to the earth.—E. E. Brownell before the American I.E.E.

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Horizontal-Vertical Engines.

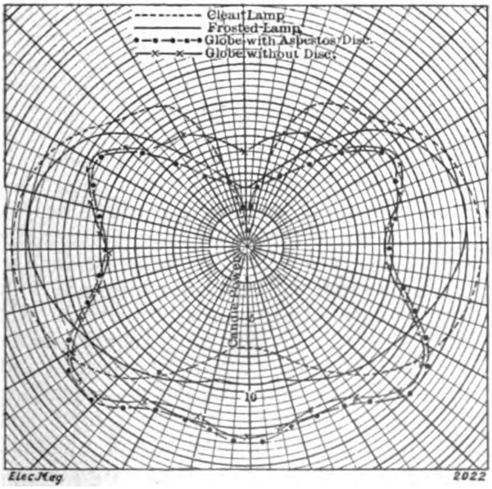
In our February issue we published in this section a view of the New York Subway power-house, which contains the now famous Reynolds horizontal-vertical engine, and of which we gave particulars of tests in our last issue. The idea of this type of engine was first conceived by Mr. Reynolds under rather remarkable circumstances, which make very interesting reading. The incident referred to occurred at the time when the Allis-Chalmers Company was called upon for advice as to the type of engines to be used in the new power house then being planned by the Manhattan Railway Company, New York City. It was the intention of the railway company's engineers to install units of 5000kw. capacity. The first type of engine considered was the cross-compound, vertical machine, similar to those furnished for the Metropolitan Street Railway Company's power house, and some correspondence passed between Mr. Reynolds and the engineers of the Manhattan Railway Company on the subject, so that finally Mr. Reynolds was invited to come to New York and discuss the matter in detail. Mr. Reynolds left Milwaukee with the question of the type of engine still unsettled, but with the understanding that the straight, cross-compound, vertical unit would be used if it were found practicable. On the train en route for New York, however, Mr. Reynolds evolved in his mind the possibility of using a combined vertical and horizontal engine, allowing four cylinders to be connected to the one shaft, and before reaching New York he was prepared to offer to the engineers in charge a definite proposition, covering a combined vertical and horizontal four-cylinder engine, now generally known as the " Manhattan " type, and, furthermore, he submitted to them the size of cylinders which he would recommend, the size of crank pin and cross-head pin and the size of main journals, with rough sketches of the proposed unit as he had planned it in his mind's eye. As a result of that conversation the Allis-Chalmers Company received orders for eight pairs of such machines. On Mr. Reynolds' return to Milwaukee work was at once begun on the design of the new engines in accordance with the data used by him in his New York proposition. When the complete designs were ready it was found, by comparison, that in the rough notes made by Mr. Reynolds while on his way East, he had arrived at identically the same dimensions of various parts as those obtained from the carefully worked out designs. It is said that this incident is only one of a great many which have occurred during Mr. Reynolds' long service with the old E. P. Allis Company, and later with the Allis-Chalmers Company, which display his wonderful engineering ability and his promptness in making decisions.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

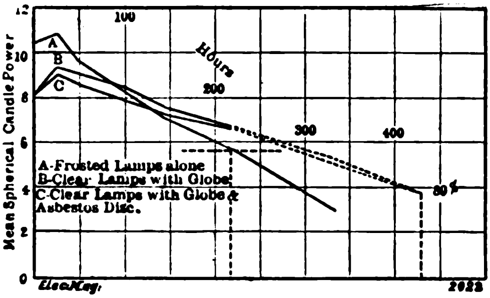
* * *

The Use of Frosted Bulbs and Enclosing Globes.

EARLY ideas of illumination were in no way associated with the obtaining of a pleasing effect from the light source. A naked light innocent of diffusing devices represented the highest standard of artificial illuminating, and to this day the greater percentage of the lamps in use is unprovided with reflectors or diffusers of any kind. To the illuminating engineer it is a matter of importance to know the value of the most common diffusing appliances in use and their influence on the life of the lamps with which they are employed. It is generally admitted that a frosted bulb absorbs about ten per cent. of the light emitted, and also that diffusing globes cut off from twelve to twenty per cent. of the light they enclose. Globes separate from the lamp are in addition liable to become obscured by the intrusion of dust, and to prevent this a reflecting washer, preferably of asbestos, should be employed.



Light Distribution from Clear Lamps in Globes and Frosted Lamps.



Curves showing the Influence of Frosting and Globes on the Life of Lamps.

With a view to ascertaining the effect of acid frosting and enclosing globes on the life of incandescent lamps, Messrs. Cravath and Lansingh carried out a number of tests on some lamps taken from the maker's stock and arranged in groups as (1) frosted lamps, (2) lamps with globes, (3) lamps with globes and asbestos discs. Particulars of these tests were recently communicated to the *Electrical World*, forming the subject of an interesting article. From this article we reproduce two sets of curves setting forth graphically the results obtained, and these will be found on examination to be self-explanatory. The enclosing globes were of the "Holophane" spherical pattern, 6½in. diameter with 3¼in. holders.

The net results were given in a small table as follow:

	Frosted. Hrs.	In globes. Hrs.	In globes with discs. Hrs.
Average life to 80 per cent. of initial c.p.	216	428	423
Corresponding candle-hours.	2383	4401	4384

The use of the asbestos discs, which is due to the authors mentioned, increases the light in the lower hemispheres about two per cent. for a loss of life of one per cent., but the chief gain is derived from the absence of dust on the interior of the globe. Summing up, it is stated that the average life of a clear bulb-lamp is 450 hours; by enclosing them in globes the loss of life is about 5½ per cent., while the loss due to frosting the bulb is given as fifty-two per cent., a marked difference in favour of the globes.

Problems in Illuminating.

The science of illumination should very shortly be greatly advanced by the collection of valuable data on the subject into text-books and works of reference, for certain it is that such data will before long become both comprehensive and valuable. Our youthful but esteemed contemporary, *The Illuminating Engineer*, is already leading the way with a series of articles on practical illuminating problems, and judging by the standard of these the subject is generally being attacked in a systematic way. The author, Mr. A. A. Ernst, in the first of the series says, "In order to determine the intensity of illumination produced on a given surface at any given point with reference to a light source of known distribution, the following formula is used:—Intensity of illumination equals the quotient of the candle-power divided by the square of the distance of the light above the surface, multiplied by the cube of the cosine of the angle at which the ray strikes the surface. Reducing this to an algebraic equation—

$$I = \frac{C}{H^2} \text{Cos}^3 A$$

As this formula is one which will be constantly used, a table showing the values of the cubes of the cosines of the various angles will be a great convenience. In the following table these are given for angles from 1deg. to 72deg. —

Angle.	Cos³.	Angle.	Cos³.
1	1.000	37	.509
2	.998	38	.489
3	.998	39	.469
4	.993	40	.449
5	.988	41	.429
6	.983	42	.410
7	.978	43	.391
8	.971	44	.372
9	.963	45	.353
10	.955	46	.335
11	.945	47	.317
12	.935	48	.300
13	.925	49	.282
14	.913	50	.265
15	.901	51	.249
16	.888	52	.233
17	.874	53	.218
18	.860	54	.203
19	.845	55	.189
20	.829	56	.175
21	.813	57	.161
22	.797	58	.149
23	.780	59	.137
24	.762	60	.125
25	.744	61	.114
26	.726	62	.103
27	.707	63	.0936
28	.688	64	.0842
29	.668	65	.0754
30	.649	66	.0671
31	.630	67	.0596
32	.610	68	.0526
33	.590	69	.0460
34	.570	70	.0400
35	.550	71	.0345
36	.529	72	.0295

With this table the candle-power of the units, their heights and distances apart, can be proceeded with, and we hope it may in itself prove useful to our readers.

Interior Illumination.

The artificial lighting of interiors is generally carried out in a most perfunctory manner whether electricity or gas be the illuminant, and the time has certainly arrived at which something must be done to provide a room with light in conformity with and proportion to its decoration and furnishing. The public are only vaguely aware that dark papers on a wall absorb light and do not reflect it, but even this merest inkling of lighting principles is disregarded and seldom acted upon in the design of a lighting installation. Again a common error is too much light with no regard whatever for its proper utilisation. Take desk lighting as an instance. A powerful lamp and a brilliant reflector will furnish light enough for many square feet of floor space, and the user of so strong an illuminant will suffer from at least two damaging effects of the arrangement: one is represented in a lighting bill out of proportion to the service given, and the other is impaired eyesight. Desk lighting as ordinarily carried out will bear with considerable reduction in its intensity and with immediate good results. White surfaces such as papers and book matter act as powerful reflectors, and in the case of desk lamps the reflection is back towards the eye of the worker over the sheets and pages. German physiological studies have revealed a so-called "visual purple" in the human eye which is susceptible to and is disintegrated by light. The system repairs the loss in a normal way, but when the light source is powerful enough to outbalance the forces of recovery, fatigue of the eye results, and ultimately injury.

The investigations of the newly formed group of illuminating engineers are furnishing evidence from all sides of the common tendency to error on the side of too much light for interiors, whether domestic or commercial. Frequent experiences point to material improvement in the distribution of light when the number of "points" has been reduced, and the tendency to be inferred from this is one which will encourage rather than retard the growth of the illuminating engineering movement.

The lighting of many work benches in a large shop at which fine detail work is undertaken is a problem which good lighting principles suggest should be solved by good distribution from a few units rather than separate concentration of the light at the individual points of use. The case may be regarded as one in which natural light should be imitated as closely as possible, and for this reason a few powerful lights give by far the best results.

It must of course be borne in mind that the public, who are the chief light users, will need educating up to the principles and rules which are directly contradictory to their long-cherished idea of lighting. They believe that plenty of light is needed, and in an illuminant like gas their fancies are specially catered for and their ideas become fixed until they assume the importance of a law binding upon all. It must not be assumed that the illuminating engineer in his treatment of interior illumination will be guided blindly by the notion that a minimum of lights must be installed at the expense of the volume of light emitted. On the contrary it will be his business to provide *effective* interior illumination quite regardless of what his predecessors have done with any other illuminant than that which he is engaged in introducing.

Light Distribution.

In his recent Institution paper on long-flame arc lamps, to which we referred last month, Mr. L. Andrews included two figures which appropriately compare the respective merits of lamps placed near to and at a distance from the floor, from the standpoints of light distribution and energy consumption. These diagrams will be found very useful for reference.

Curves A_1, B_1, and C_1, Fig. 1, show respectively the illumination per square foot on the floor space of a room illuminated by 800-watt high-voltage pure-carbon long-flame arc lamps with globes half obscured at A A, 25ft. above the ground, and with similar lamps fitted with globes absorbing 40 per cent. of the light at B B B, 20ft. above the ground, and with 460 watt ordinary enclosed arc lamps at C C C, 10ft. above the ground. It will be seen that the mean illumination is approximately the same in each case, but that a considerable saving of energy is effected by using unobscured flame

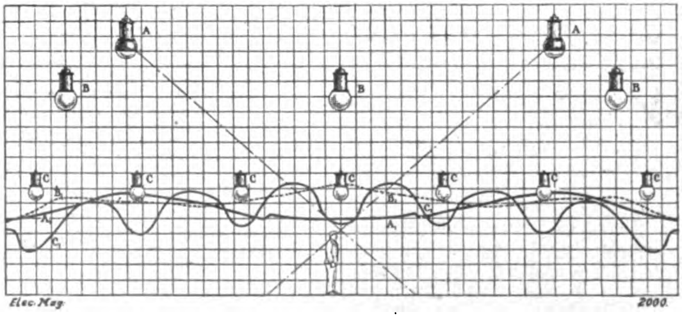


Fig. 1.

lamps 25ft. above the floor level. It is also noticeable that the distribution of light is much more even with the few lamps placed high up than with the larger number of lamps nearer the floor. Fig. 2 shows the arrangement of lamps required to produce a given mean illumination over a given floor space, the energy expended with the three systems being respectively as follows :—

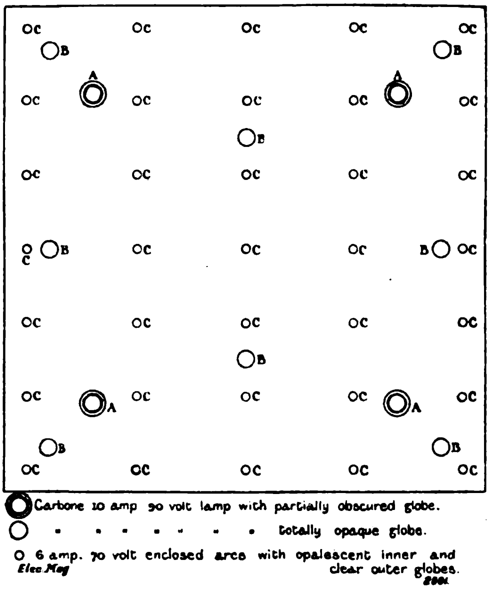

OC
A
B
Carbone 10 amp 90 volt lamp with partially obscured globe.
" " " " " " " totally opaque globe.
O 6 amp. 70 volt enclosed arcs with opalescent inner and clear outer globes.
Elec Mag

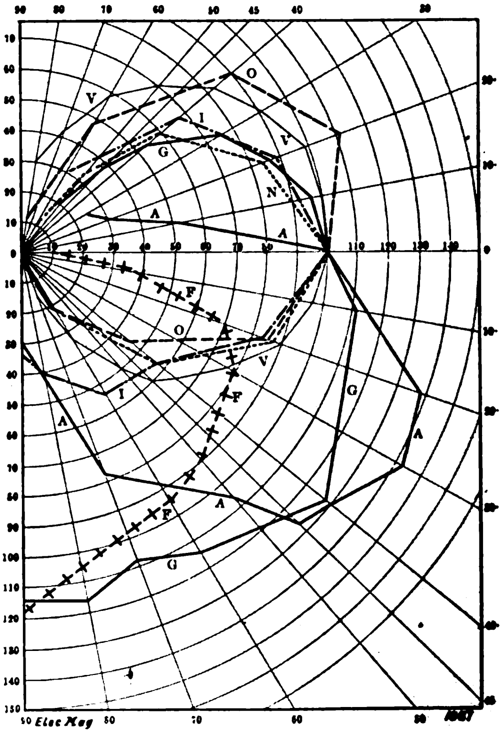
Fig. 2.

Four 800 - watt unobscured high-voltage flame lamps...	3,200 watts
Eight 800-watt obscured high-voltage flame lamps	6,400 watts
Thirty-five 460-watt enclosed arcs	16,100 watts

It is obvious that by doubling the height of all the lamps a floor space of four times the area would be illuminated to one-fourth the brilliancy.

Light from Various Sources.

We have not previously seen a set of illumination curves of the well-known sources of artificial light plotted on one sheet for purposes of immediate comparison. Professor H. Drehschmidt has recently published in a German gas contemporary such a series of curves, which we reproduce herewith, as of great interest. The amount of illumination at different angles above and below the horizontal is clearly shown, and the comparisons possible are very striking. Referring to the illustration, curve V represents the now common Welsbach burner, and G the new inverted type, and here the difference in the distribution is very marked. With the Welsbach light quite half the light is distributed above the lamp, while with the inverted burner not much more than a quarter is shed in this direction, the greater part finding its way to the most useful spot below the horizontal. The other curves are plotted from electric lamps. O is the osmium, N the Nernst, I the carbon incandescent, A the common arc, and F the flaming arc. With the exception of the common arc lamp the distribution from these various types is not so good as it might be, while with the flame lamp too much light is concentrated below the lamp. The curves will serve for reference for some time, as little material alteration will be made in the light sources compared for a few years yet. The measurements were taken by an arrangement employing a mirror attached to a jointed parallelogram, whereby the light at any angle is directed horizontally for photometer measurement.



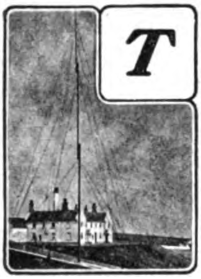
Distribution Curves of Light from Various Sources.

TELEGRAPHY & TELEPHONY

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Some German Telephone Instruments.

By Dr. ALFRED GRADENWITZ.



THE increase in the use of the telephone in Germany has been phenomenal of late years, and some very important systems have as a consequence been put into operation. To supply the demand for instruments a number of large manufacturing firms have sprung up, and the high standard to which their products have been raised indicates a flourishing condition in the telephone industry. A glance at a few representative types of instruments will, therefore, be of some interest.

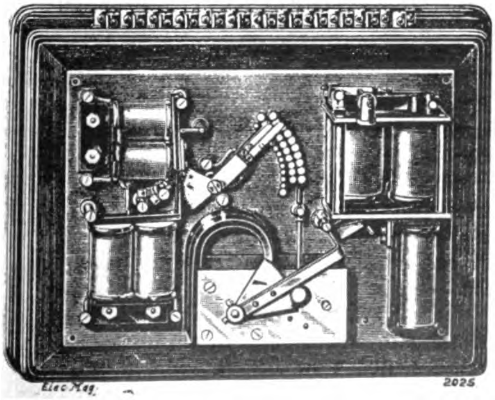


Fig. 1. Automatic Switch of Arnheim Selective Telephone System.

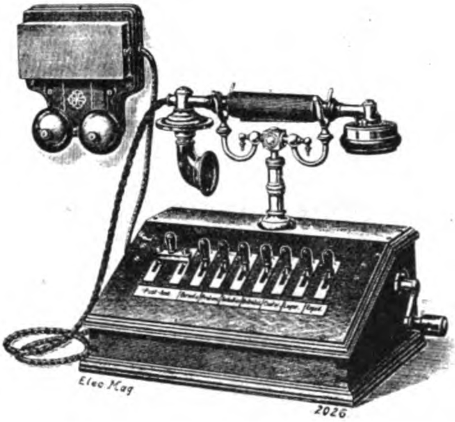


Fig. 2. A Desk Telephone set with Calling Keys, for the Arnheim Telephone System.

The Arnheim system is arranged for use on either the trunk exchange or a private wire and has a fewer number of conductors than is usual with other systems. An automatic switch, shown in Fig. 1, is included in the system, and its operation ensures quick connection at all times. It effectively locks out any third party on the line and also makes the conversing parties proof against overhearing. The magnetic switch operates a contact arm which stops at the number selected by the calling switch. A handy desk set is shown in Fig. 2, and the calling switches will be noticed in this illustration, the signal being given by a magneto machine. The connections of the system allow the exchange to ring up any of the secondary stations coupled on the line, and, *vice versâ*, the arrangement permitting the call to be made without disturbing any other parties on the line.

A very interesting type of small exchange is the "Triplex," shown in Fig. 3, serving for the connection of secondary circuits of the Postal Department, which in Germany controls the telephone traffic, and private secondary circuits, its operation being the same as that of an ordinary switchboard. The secondary stations connected to the switchboard can be coupled both to the circuits leading to the exchange and to private circuits, while no connections between the exchange and private circuits should be possible according to the regulations of the Imperial Postal Department. To this effect any jacks are short-circuited in case such illegitimate connections are made, so as to prevent any ringing-up or talking from a private circuit to the Postal circuits and *vice versâ.*

The Janus telephone system has been very widely adopted on the Continent in business and manufacturing establishments, and has been especially designed for communication with the exchange and with private secondary stations. This double service (embodied by the name of Janus) ensures a high degree of rapidity and ease in connection with any telephonic conversation, as all supplementary apparatus has so far been dispensed with. The dual connection is obtained by the addition of a special switch located on the desk of the subscriber.

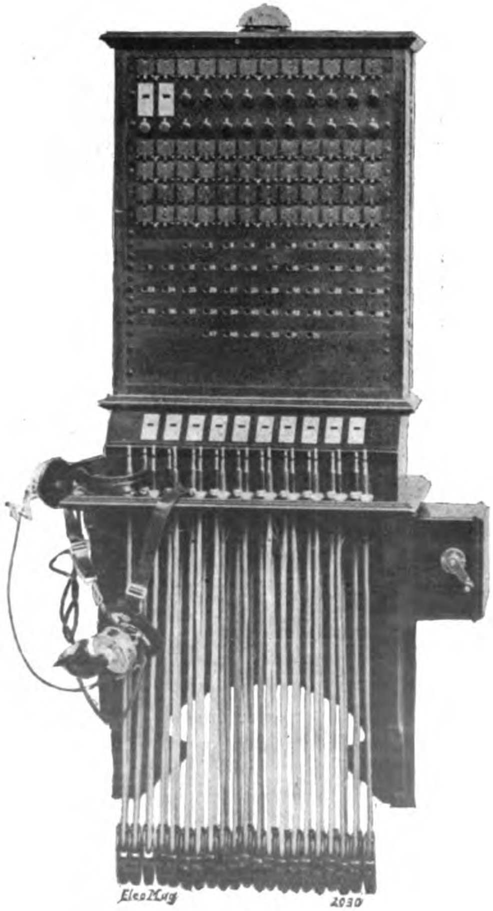


Fig. 3. Plug Board of a Small Telephone Exchange, known as the "Triplex."

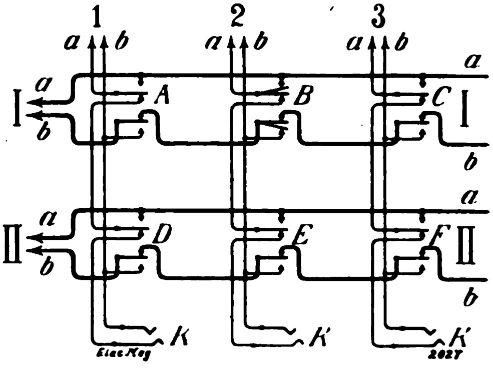


Fig. 4. Diagram of Connections of the Janus Intercommunication Telephone System.

The principle of the Janus arrangement is illustrated in Fig. 4, in which Iab and IIab are two lines leading to the exchange, and 1ab 2ab and 3ab the secondary station conductors running transversely to the exchange lines. Switching is effected by the double Morse keys represented in the figure, which are so designed that by pressing a button two contact springs are lifted from their rest contacts and applied to the working contacts placed in front, when the keys are fixed in position by a slight twist. These switches are designated in the figure by A, B, C, D, E, F, respectively, to which the conductors have been so connected that from the a-conductor of the exchange line any connections are branched off in parallel, whereas the b-conductor runs consecutively over the switches of the main line. In connection with the conductors of the secondary station the b-conductors are branched off in parallel, while the a-conductors are led in series over the switches of each secondary line.

With the wires of the exchange line I the a-conductor is thus branched off in parallel to the switches A, B, C, while the b-conductor is first applied to the lever of the switch A and then from the rest contact of the latter to the lever of B, from the rest contact of which it is applied to the lever of C, &c. In the same manner the conductors of the exchange line II have been arranged over the switches D, E, F. In the conductors of the secondary station the b-conductor is connected to the working contact of the lower levers of the Janus switches lying below one another (A, D or B, E or C, F), whereas the a-conductors are coupled to the upper levers of the Janus switches. The conductors of a secondary station terminate in jacks K of normal design for loop circuits.

Connection with an exchange line is effected in the following way. If, for instance, the switch B be pressed down, the levers will be lifted from their resting point and applied to the working contact, thus applying the a-conductor of the exchange line I to the a-conductor of the secondary station line 2, whereas Ib is connected to 2b. The two circuits I and 2 will now be connected, while at the same time the jack belonging to the circuit 2 is switched off. It is thus impossible by means of a plug to effect any connection of the secondary station with any other circuit. Fig. 5 illustrates a desk type of telephone fitted with special Janus switch.

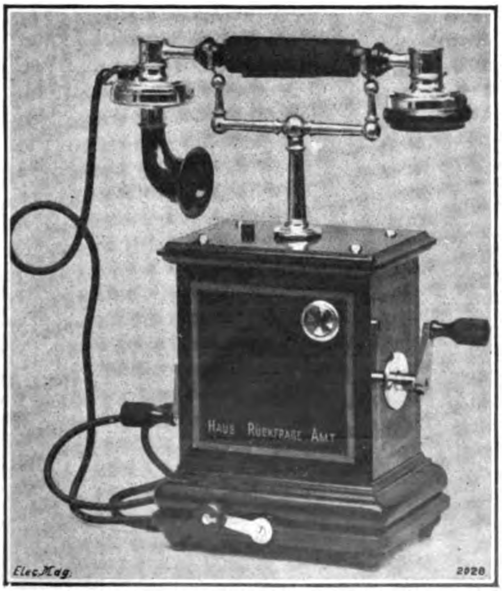


Fig. 5. Desk Telephone, with Janus Switch fitted in the Instrument Case.

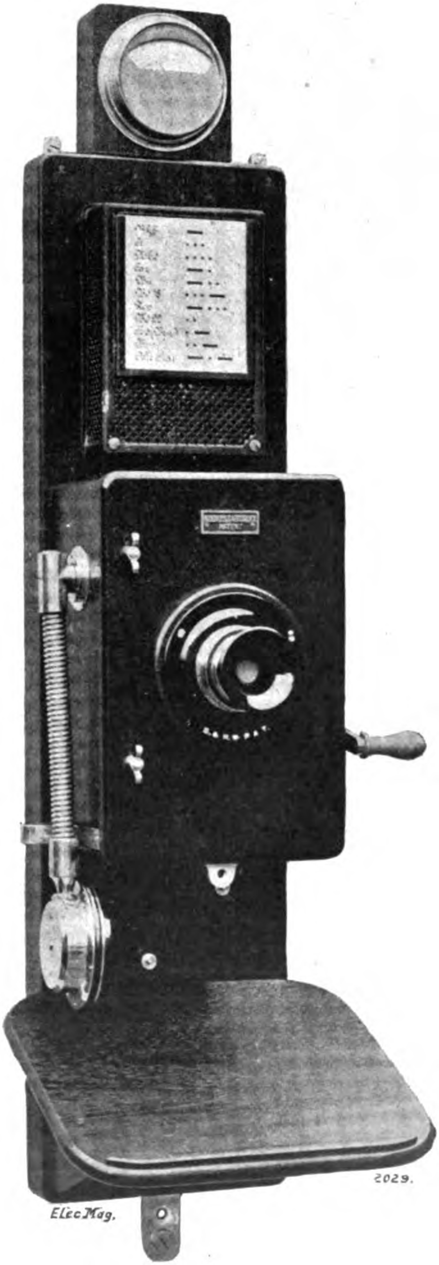


Fig. 6. Special Type of Telephone used by the Prusso-Hessian Railways.

The number of Janus switches depends both on the number of exchange and secondary station lines. With a switchboard comprising four exchange lines and twenty secondary station lines, there are for instance as many as eighty switches required. Now

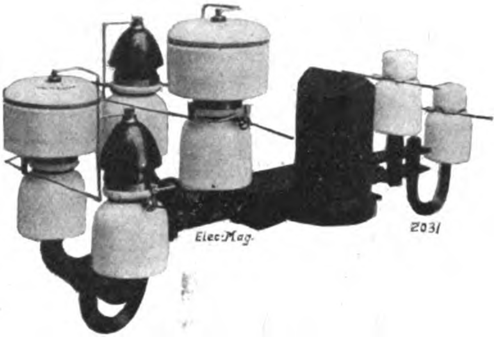


FIG. 7. SET OF PUPIN COILS, MOUNTED WITH INSULATORS AT THE HEAD OF A TELEPHONE POLE.

in view of the increasing difficulty of attendance for any greater numbers of Janus switches, the buttons above referred to are being used only with switchboards, including one or two exchange lines, whereas with any greater number of exchange lines the crank system, based on the same switching principle as the button system, is made use of.

A track telephone as used on the Prusso-Hessian Railways is shown in Fig. 6. This telephone embodies a successful attempt to replace telegraphic operation in railway service by telephonic communication with any block stations and guards' cabins situated between two train-signalling stations. A special feature of this telephone is the volume and purity of the sounds transmitted, which are quite free from any disturbing noises and as far independent as possible of atmospheric effects.

Fig. 7 illustrates the upper part of the poles of an aerial telephone circuit on which Pupin coils are mounted in the place of ordinary porcelain insulators.

Experiments to illustrate the effects of the Pupin system have been made over a cable 0.5 mm. in diameter, and a total length of wire of 9 miles. At uniform intervals Pupin coils were inserted in this conductor, care being taken to allow of all the coils being switched out simultaneously with a single manipulation, and switched in again with the same rapidity. In this way an immediate comparison of the quality of the sounds in a circuit fitted or not fitted with coils was made possible. The difference was extremely striking, the speech transmitted being of considerably greater volume and distinctness with the coils inserted than when talking through the cable without coils.

Telephone Problems.

WE have a rural line, with six stations, running about twelve miles into the country, and for about seven miles it runs parallel with a power line of 11,000 volts on opposite side of road. The line is transposed every fifth pole, but that does not take off the noise. We cut in a repeating coil, which eliminated the noise, but makes it hard to ring through. We cannot get our parties all the time, the ring being so weak it cannot be comprehended. Our system is central energy in town, but the rural line is magneto. What can be done to overcome this difficulty in ringing and still keep off the noise? What is your idea about grounding cable sheaths? We have a great deal of lightning, and have had several cables burned. Would grounding the cable sheaths help?

It is a good plan to ground the cable sheaths thoroughly to prevent lightning troubles. If you have trolley lines, you will have to look out for electrolysis. If your cable is insulated it is possible for charges to exist on it which can become disruptive and will practically gut the cable. By grounding the charges leak off and prevent any rise of dangerous static potential. Ordinarily, you should have no trouble at all, paralleling a 11,000-volt line. If it makes noise on your lines it indicates a leak on the power line, which should be looked up. The fact that a repeating coil helps, shows that you have a leak on the telephone circuit which parallels the power line. We would then presume one side of your line quiet and the other part noisy, when separately listened on by a receiver. If the insulation of both lines were in perfect condition, you would need no repeater. If it is static trouble, instead of a repeater, you can bridge a 1600 ohm ringer across the line and thoroughly ground the middle point. This will allow you to ring. I suspect bad insulation on both power and telephone line somewhere.—*Telephony*.

A Unique Event and a Unique Record of it.

Our Great International Issue will create business. The publicity we shall give it will bring prompt and substantial returns to Electrical Manufacturers represented in it.

ELECTRICAL DESIGN & Manufacture

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Regulating Turbo-generators.

In many cases, particularly in plants where water or steam turbines are installed, it is desirable to operate large exciter units which will supply exciting current for the whole station and which will also operate certain auxiliaries, such as the oil pumps, electrical governors on the turbines, and the like. Under these circumstances it is not desirable to regulate the turbine-driven generators by regulating the voltage of the exciter, since the changes in the voltage required of the exciter might objectionably affect the other apparatus supplied by the exciter. To overcome these difficulties and at the same time to permit the use of a single exciting source, W. L. R. Emmet of Schenectady, N.Y., has arranged a system which makes use of a booster between the exciting source and the generator to be regulated, varying the voltage of this booster by means of a suitable regulator so as to obtain the desired voltage or current at the generator. The regulator employed for controlling the booster is the well-known Tirrill regulator.

Referring to the accompanying diagram, (1) indicates a source of exciting current for supplying any desired number of translating devices at the station. This source may be a single large exciter or it may be any other suitable source of direct current—such, for example, as the ordinary electric-light supply mains.

Since the exciter is driven so as to have ordinarily a constant voltage, regulation of the voltage or current supplied to the field of the machine (2) is provided for by making use of a boosting set consisting of a generator (9) in series, for example with the leads (7), which generator is mechanically driven by an electric motor (10), receiving its power from the exciter bus-bars or mains (11) and (12).

To control the booster in response to the requirements of the generator (2), a suitable regulator is made use of—such, for example, as the Tirrill regulator. The portions of the regulator responsive to voltage consist of two floating contacts (13) and (14), each carried by pivoted lever arms (15) and (16), respectively. Each lever arm is controlled by a solenoid and core. The solenoid (17) receives the voltage at the terminals of the field-exciting circuit of machine (2). The solenoid (19) receives by means of a small transformer (21), a voltage proportional to that developed on the alternating-current side of the generator (2).

The contacts when they come together or separate serve to control a differentially wound relay magnet (22). This magnet has two windings. Winding (23) is connected across some source of current, such as the bus-bars, while the other winding is adapted to have its circuit closed by the contacts across the same source. Thus when the contacts are closed the two windings neutralize each other, and when the contacts are open the winding (23), being no longer opposed by its companion winding, then becomes effective.

When the magnet (22) becomes magnetized in the manner described it draws down its armature and completes the circuit by contacts (26) about a regulating resistance in series with the field windings of the booster (9). Upon the demagnetization of the

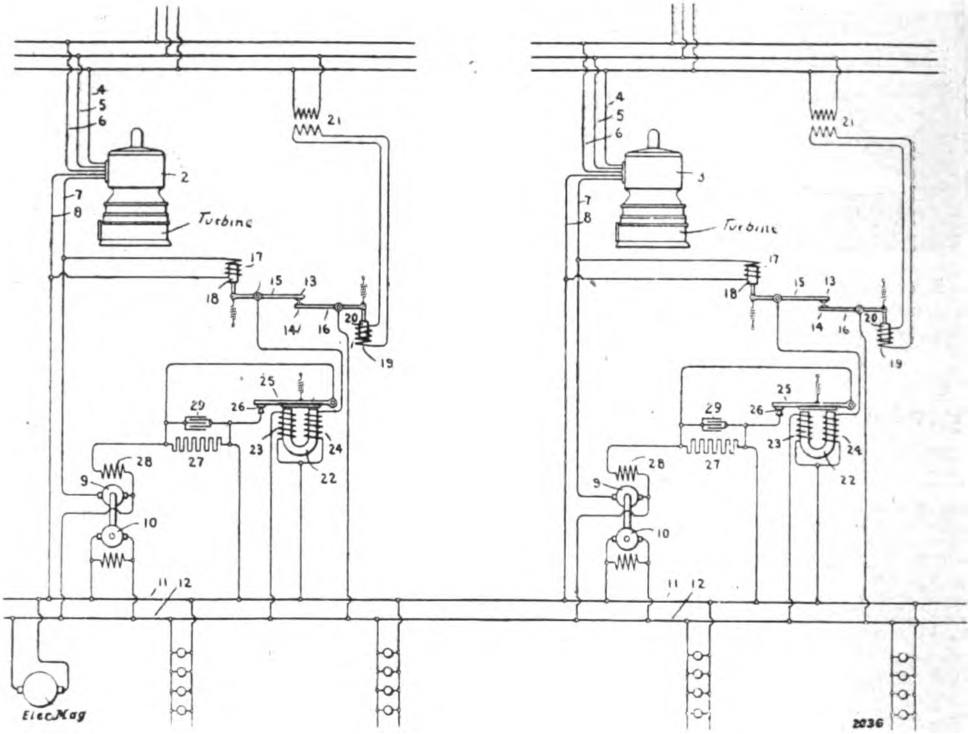


DIAGRAM OF CONNECTIONS FOR REGULATING SYSTEM FOR TURBO-GENERATORS.

magnet the contacts (26), which are shunted by a condenser to reduce sparking, are opened and resistance inserted in circuit. This resistance is so large that it tends to produce an excessive change of voltage. The contacts therefore keep up a rapid opening and closing, so that the resistance, being in circuit only part of the time, produces as a net effect the desired regulation. Thus, if the voltage on the alternating-current mains of the generator rises above normal the solenoid (19) causes the contacts (14) to be brought into temporarily longer engagement with the contact (13). This causes the magnet (22) to be de-energized and thereby opens a shunt circuit about the resistance (27) and includes the latter in circuit with the field of the booster (9). The booster voltage, which in this case is supposed to be added to that of the exciter source, is then reduced. This reduction of voltage is immediately felt by the controlling solenoid (18), whereupon the contact (13), controlled thereby, recedes from the lower contact (14), thus opening the circuit of the magnet (22), which had just been closed. This opening of the circuit in response to the field exciting voltage takes place more promptly than would be the case if the apparatus were constructed so as to open the contacts only after the alternating voltage of the machine had been reduced and the weakening effect transmitted to the solenoid. This promptness of action of the regulator prevents the surging or hunting of the voltage of the machine which would otherwise take place. The voltage having been thus adjusted, the contacts continue to vibrate regularly until some change of voltage occurs requiring correction, whereupon an action takes place similar to that already described.—*Western Electrician.*

Iron Losses in One-Phase Motors.

It is a well-known fact that the iron losses of a direct-current armature or of a three-phase armature are considerably larger than those in the core of a transformer, induction periodicity and volume being the same in the two cases. Dr. Niethammer points out in the *Electrical World* that in the first case the magnetization is produced by rotation of an iron body in a magnetic field, and in the second case there exists a local periodical variation of the field. In a single-phase series motor both kinds of magnetizations are combined; at standstill there is only a transformer action, but after being started the armature of such a motor rotates in an alternating field. There are two widely different periodicities which have a bearing on the iron losses of a single-phase commutator motor, viz.: the periodicity n_r, of rotation, equal to the number of revolutions per minute multiplied by the number of the poles of the motor and divided by 120. From a theoretical standpoint it is difficult to decide in which way the total iron losses depend upon these two periodicities. Steinmetz states that up to synchronous speed the iron losses of series motors depend upon n, and that above synchronism they vary with n_r, which seems entirely logical.

In order to ascertain in just what manner the iron loss varies with the speed, a simple experiment was performed using the circuits shown in Fig. 1. The field F, of the single-phase commutator motor, K, is excited by an alternating current, A_c, and the open-circuited armature, K, is driven by an auxiliary direct-current motor, H. The watts, A_e, input to the field and the watts input to the auxiliary motor were measured once when F was not excited (A_1) and then when F had a definite alternating-current excitation (A_2). The test conditions corresponded to those found in compensated series motors. The difference, $A_m = A_2 - A_1$, of the last two values gives the watts iron loss supplied to K by the auxiliary motor, H (if all necessary precautions are taken), and the first-mentioned watts are the iron losses supplied by the alternating current in the field coils. The sum of the two values, $A_e + A_m$, gives the total iron losses.

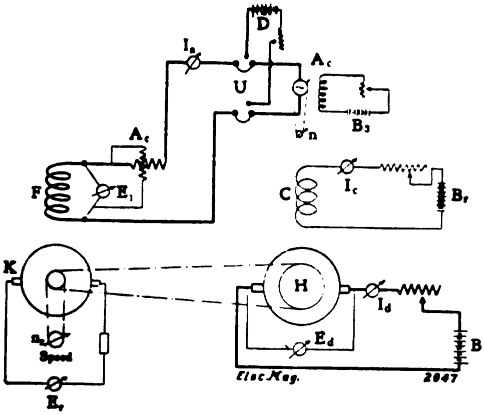


FIG. 1.

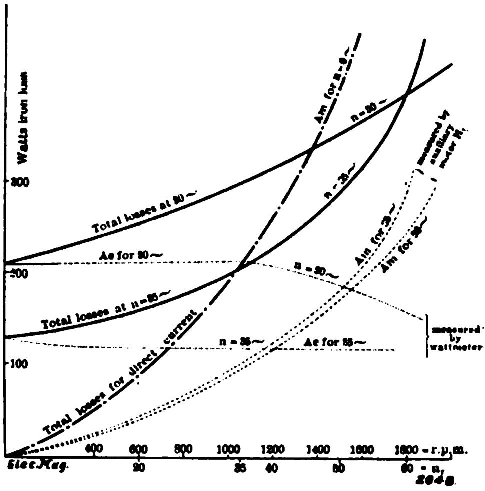


FIG. 2.

The motor tested was a four-pole machine with an output of 7 h.p. at 1500 r.p.m. It is constructed with an equally distributed series winding in stator and rotor covering the whole circumference (no definite poles). The measurements were made at speeds from zero up to 1800 r.p.m. for two periodicities, 35 and 50, and for two magnetic fields equal to about the full-load field and about half of this value. The value of the armature field, F_a, was determined from the open e.m.f., E, of the armature, R, and that of the primary field, F_f, from the field voltage, E. All necessary corrections were made on the measured results of the commutator motor, K, as well as on those of the auxiliary motor, H.

For purpose of comparison the iron losses with direct-current excitation were also measured by changing the position of the reversing switch, U, on D. The results are shown in Figs. 2 and 3; Fig. 2 for the larger flux and Fig. 3 for the smaller flux. The curves in full line refer to the total losses, which are made up of the two dotted curves which represent singly the losses measured by the wattmeter, A_c, and by the auxiliary motor A_m. The dot-and-dash curve refers

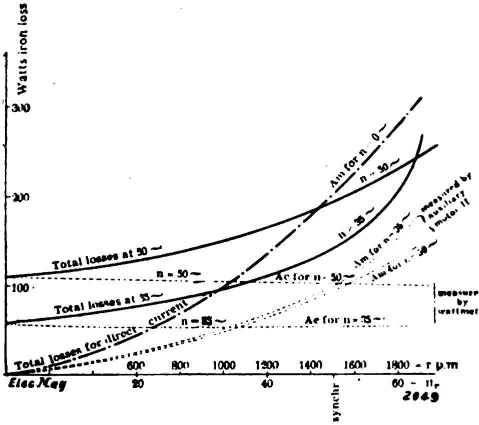


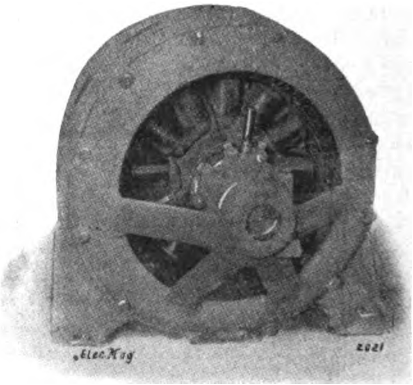
FIG. 3.

to direct current. For small speeds the total iron losses are the smallest for low periodicities, but for high speeds the ratio is reversed and the losses are largest for low periodicities. In fact, the curve for 35 periods crosses the curve for 50 periods, and the curve representing the direct-current losses crosses, first, the curve for 35 periods, and later on the curve for 50 periods, the flux remaining constant.

A knowledge of the character of these curves should be of value in connection with single-phase motors used for intermittent work where starting and stopping occur frequently, for example, for traction purposes on urban lines. It may be noticed that in this special case the intersection of the direct-current curve with the alternating-current curves takes place in the neighbourhood of the synchronous speed; that is, at a point where n_r is nearly equal to n.

Self-Exciting Alternators.

In our last issue we gave some particulars of a new design of self-exciting alternators taken from an American Institute paper presented by Mr. E. F. Alexanderson. From the same source we take a few additional particulars of some machines actually built which may be of interest. A special exciting winding is placed in the same slots with the main armature winding, and furnishes the current which passes through the commutator to the field. As shown in the diagrams last month, this exciting winding is of the star connected three-phase type, the neutral point of which is formed by a three-part rheostat. Each limb of this is connected with one coil of a three-phase series transformer whose primary receives the load current. The induced current from this transformer opposes the field current, and is in phase with the line current, while the field current is practically in phase with the voltage. This arrangement makes the amount of boosting of the field current dependent upon the power factor of the load. The author states that a number of these machines operate very successfully in parallel both with ordinary machines and those of the self-exciting type. The principle is also applicable to synchronous motors, and such a machine can be either shunt connected or compounded; the latter type has been found useful for boosting purposes at the ends of long transmission lines. In this case the series transformer is so connected with the main line that the excitation is increased with an increase of load. We understand that the manufacture of these machines is now being taken up by a big American manufacturing firm.



200KW. SELF-EXCITING ALTERNATOR FOR BELT DRIVE.

British Electrical Enterprise.

See our great International Number for an up-to-date account of this. You will want it for reference. See you get it.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

* * *

The Mechanical Equivalent of Light.

By EDWARD L. NICHOLS.

(Concluded from p 312.)

By making use of Angström's curve of intensities for the Hefner lamp and the corresponding curve for the acetylene flame similar curves may be plotted for all other sources of light which have been compared spectrophotometrically with either of these; and if such curves be drawn in such a way as to represent in each case a light source of unit photometric intensity a comparison of their areas, taken for the whole of the visible spectrum, gives the mechanical equivalent of light for each source in terms of that of the hefner. I have shown in a recent paper[*] that the mechanical equivalent thus computed is not constant but varies through considerable range with the character of the light. The smallest values are those for sources strong in the wave lengths of high luminosity in the middle of the spectrum and *vice versa.* Tables I., II., and III. give the results of such computation for three distinct groups of light sources. The mechanical equivalent is expressed in watts of the total light flux when the mean spherical intensity of the source is one hefner.

Table I.—Luminous Flames.

SOURCE.	Mech. equivalent of light as below.	
	Ergs of luminous energy per cm.^{2} of surface when illumination is one lux.	Total light flux in *watts*, for a photometric intensity of one hefner.
Hefner Standard . .	8.68 ergs per sec.	0.1090 watts.
Petroleum Flat wick . .	9.13 ,, ,,	0.1148 ,,
Petroleum Triumph burner	8 69 ,, ,,	0.1092 ,,
Illum. Gas Batswing . .	8.45 ,, ,,	0.1062 ,,
Illum. Gas Sugg burner .	7.70 ,, ,,	0.0968 ,,
Acetylene	7.12 ,, ,,	0.0892 ,,

Table II.—Carbon—Electrically Heated.

SOURCE.	Temp.	Mech. equivalent of light as below.	
		Ergs per cm.^{2} per lux.	Watts of total light flux per hefner.
Carbon rod (untreated)	1000°C	29.0 ergs per sec.	0.364 watts.
	1100°	23.15 ,, ,,	0.291 ,,
	1200°	17.80 ,, ,,	0.223 ,,
	1300°	14.20 ,, ,,	0.179 ,,
	1400°	9.14 ,, ,,	0.114 ,,
Lamp filament (Angström)	1727°	7.26 ,, ,,	0.0912 ,,
Lamp filament (treated)—Blaker.	1078°	18.5 ,, ,,	0.217 ,,
	1255°	9.69 ,, ,,	0.122 ,,
	1328°	7.38 ,, ,,	0.0928 ,,
	1496°	7.34 ,, ,,	0.0793 ,,
	1648°	6.35 ,, ,,	0.0798 ,,
	1738°	6.42 ,, ,,	0.0807 ,,
Arc	—	5.80 ,, ,,	0.730 ,,

Table III.—Metallic Oxides.

SOURCE.	Mech. equivalent of light as below.	
	Ergs per cm.^{2} per lux.	Watts of total light flux per hefner.
Zircon	7.17 ergs per sec.	.090 watts.
Lime Old	5.89 ,, ,,	.074 ,,
Lime New	7.21 ,, ,,	.096 ,,
Welsbach Mantle . . .	4.44 ,, ,,	.056 ,,
Magnesia (from burning ribbon)	5.53 ,, ,,	.0695 ,,

Where light is produced electrically, the efficiency, commonly expressed in watts per candle, may be given some absolute significance by the substitution of the ratio of the watts of total light flux to the watts necessary to maintain the source. This ratio, which is not identical with the radiant efficiency, because it includes the heat losses in the lamp by convection and conduction, is given in Table IV., for a treated lamp filament studied by Blaker.[*] The watts of light flux are as given in Table II.

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[*] Nichols: On the Distribution of Energy in the Visible Spectrum; Paper read before the American Physical Society, Dec. 29, 1904

Table IV.

Temperature.		Watts per hefner.	Watts of light flux.	Watts of flux. / Watts per H.
1078°C.	1351°Abs.	46.0	.217	.00506
1255°	1528°	13.8	.122	.00882
1496°	1769°	4.54	.0923	.0203
1648°	1921°	2.34	.0798	.0344
1738°	2011°	1.71	.0807	.0472

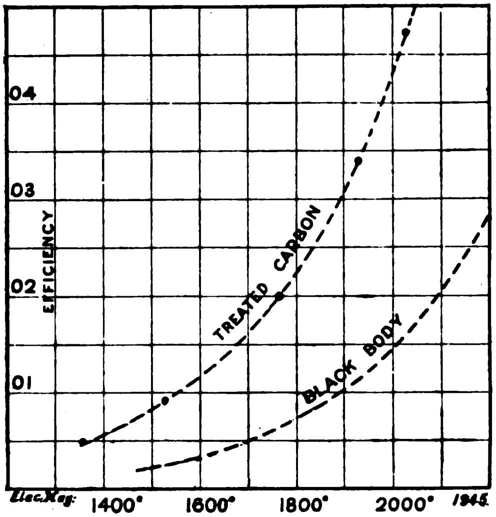

Fig. 4.

These efficiencies are greatly in excess of the theoretical radiant efficiencies of a black body for the corresponding temperatures. In Fig. 4 the efficiency of treated carbon, as given in Table IV., and the theoretical efficiency computed from Wien's Law by Mendenhall[†] are plotted as a function of the temperature. There is an almost constant difference between the two curves, which indicates the superiority of treated carbon as radiator of the visible wave lengths, long since noticed by Evans,[‡] Bottomley,[§] and the present writer.[||] The incandescence of the treated filament—for any temperature between 1400° and 1900° Abs.—is equivalent, photometrically, to that of a black body of more than three hundred degrees higher temperature. The temperature of a treated filament at a normal brightness of three watts per hefner (3.4 watts per candle) is approximately 1900° Abs., and its radiant efficiency is .032. A black body to attain this efficiency must be brought to about 2250°.

For flame sources, where the amount of fuel consumed and its heat of combustion are known, the gross efficiency—*i.e.*, the ratio between the rate at which energy is developed by combustion and the watts corresponding to the total light flux of the source—may be computed. Wedding[*] in a recent paper has published such data for numerous sources of light, basing them on measurements of his own of the total radiation, luminous radiation, and the total energy required to maintain the light. His determinations of the luminous radiation, like those of Tumlirz, were made by the method of the water cell. The other factors, however, which appear to be carefully worked out, may be used in combination with the values of the luminous radiation, already given, for the computation of the efficiency of these sources. Preece,[†] also, in an address before Section A of the British Association, has furnished estimates of the power of the fuel consumed by various flames in watts per candle. Data from both of these writers, whose results are unfortunately by no means concordant, are used in Table V.

Table V.—Gross Efficiency of Flames.

Source.	Watts per hefner.	Watts of light flux. / Watts of fuel burned.
Tallow Candle . .	109 (Preece)	.00092
Sperm Candle . .	75 (Preece)	.0013
Petroleum	70 (Preece)	.0016
Petroleum	38 (Wedding)	.0029
Coal Gas	59 (Preece)	.0016 .0015
Welsbach	53 (Wedding)	.0010
Acetylene . . .	13.5 8.0 (Nichols)[‡]	.0060 .0110

The exceedingly small amounts of energy necessary to illumination, were we in a position to effect the complete transformation, may be illustrated as follows:

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[*] Blaker: *Physical Review*, Vol. XIII., p. 357.

[†] Mendenhall: l.c.

[‡] Evans: Proceedings of the Royal Society, Feb. 18, 1886.

[§] Bottomley: Proceedings of the Royal Society, 42, 1887.

[||] Nichols: *Physical Review*, Vol. II., p. 260.

[*] Wedding: Uber den Wirkungsgrad und die praktische Bedeutung der gebrauchlichsten Lichtquellen; München, 1905.

[†] Preece: B. A. Report, 1888; also *Nature*, Vol. XXXVIII., p. 496.

[‡] See Nichols: *Physical Review*, Vol. II., p. 215.

A source, the illuminating power of which at metre's distance is equivalent to one watt per centimetre of surface, would be of more than a million candle-power, or, to be more exact, it would have an intensity

1,160,000 hefners for the Hefner flame, and about the same for candles, oil, and gas.
1,400,000 hefners for acetylene.
1,580,000 hefners for a glow lamp with treated filament at three watts per hefner.
1,690,000 hefners for the arc.

Tumlirz in the article cited in the opening paragraphs of this paper offers numerous computations of this sort, and other interesting data are to be found in a paper by Carl Hering.*

Langley has computed the minimum energy necessary to vision. For the wave lengths of highest luminosity in the middle of the spectrum his value is 2.78×10^{-9} ergs. The human eye at metre's distance from a source of light of one hefner intensity, viz., when exposed to an illumination of one lux, receives energy at a rate (about .6 erg per second) many millions of times as great as that necessary to maintain vision, and it is not altogether overwhelmed even when the intensity of the illumination rises to 1000 luxes.

Oscillation Valves for High-frequency Currents.

In a recent paper presented to the London Physical Society Prof. J. A. Fleming recalled the fact that as far back as 1890, when investigating the Edison effect in glow-lamps, he had shown that the space between the incandescent carbon filament and an insulated metal plate placed in the vacuous bulb possessed a unilateral conductivity, negative electricity being able to pass from the filament to the plate, but not in the opposite direction. This led him to suggest an arrangement of the above kind for separating out or rectifying the oppositely directed currents in an alternating current. This effect was now recognised as due to the copious emission of negative ions or electrons from the incandescent carbon. It was by no means obvious, however, before trial that any such rectifying arrangement or valve would operate with currents of very high frequency. For example, electrolytic rectifiers such as the aluminium-carbon cell were not available for high-frequency currents because a time element entered into the chemical actions involved. In 1904, however, he discovered that if the carbon filament in an electric glow-lamp was surrounded with a metal cylinder connected to an insulated terminal by a wire sealed through the bulb, and if the filament was made incandescent by an insulated battery, then between the insulated terminal and the negative pole of the battery a unilateral conductivity existed which was operative with currents of any frequency, and the valve so made might be employed to render electrical oscillations measurable by an ordinary sensitive galvanometer. Dr. Fleming exhibited oscillation valves made on this plan, and also showed their uses. If placed in series with a galvanometer, in the circuit of a coil of wire acted upon inductively at a distance by oscillations created in another circuit, the valve gives instructive information as to the damping in the primary circuit. Thus he showed that when using a carbon-point spark discharger in the primary oscillation circuit, much larger galvanometer deflections were obtained with very short sparks than with long ones. He further explained that the greatly lessened damping in the short spark caused the mean value of the secondary current to be increased, although the charge put into the primary condenser was diminished. The advantages of using multiple spark-gaps in oscillation circuits was also proved by the use of the valve. Dr. Fleming exhibited a multiple spark-gap discharger made with carbon rods, and claimed for it a much greater constancy of action than a discharger made with metal balls. Experiments were also shown illustrating the manner in which the valve is of use in showing the shielding action of thin metal sheets placed between primary and secondary oscillation circuits. Dr. Fleming also exhibited an experiment showing the copious emission of negative ions from the glower of a Nernst lamp at atmospheric pressure. A Nernst oxide glower was placed horizontally near a brass tube filled with water to keep it cool, and on glowing the oxide rod with a continuous current, it was shown that the space between the hot rod and the cool tube possessed a unilateral conductivity and would only pass negative electricity in one direction. The lecturer referred to the employment of carbon-filament oscillation-valves such as he had described as wave detectors or cymoscopes in connection with wireless telegraphy. Finally it was pointed out how, by the use of an electrodynamometer and galvanometer in series, the amount of rectification produced by the valve could be measured, and it was shown that it might amount to 89 or 90 per cent.

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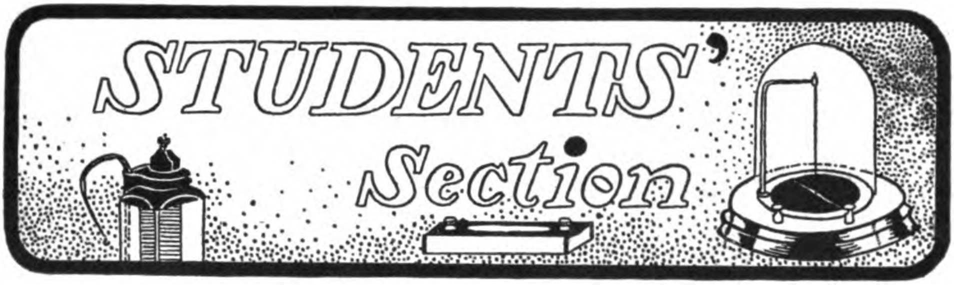
* Hering: *Electrical World*, April 20th, 1901, page 31.

Secondary Rays of Radium.

An investigation has recently been made by Herr K. Siegl and contributed to *Physikalische Zeitschrift* to determine whether the secondary rays thrown out by substances exposed to radiation from radium cause fluorescence. For the purpose of research a capsule containing a few milligrammes of radium bromide was enclosed in a thick lead case with an opening at one side. This case was placed so that the opening was directed downward against the materials to be investigated. Just above the case was a fluorescent screen, which at the point immediately over the lead was covered with black paper so as to eliminate any possibility of action due to the filtering of direct radiations through the lead. The table immediately below the bromide was arranged so that different materials could be slipped upon it, taking a definite position, and the screen was then exposed only to the secondary radiations thrown off from these materials on account of the direct radiation emitted by the radium through the opening in the lead case. The substances investigated were wood, aluminium, ebonite, glass, iron, nickel, copper, silver, zinc, platinum, gold, mercury, lead, and some other metals. These could be clearly divided into groups according to the action produced. The secondary radiations caused fluorescence of the screen to different degrees, wood having the least effect, ebonite and aluminium coming next, then iron and nickel, copper and zinc, followed by silver and tin, finally the heavy metals—platinum, gold, mercury and lead. The effect not only varied with the materials, but with the form of the sample under investigation. It appeared to depend upon the atomic weight more than upon the specific weight. It also depends upon the thickness of the exposed sheet. This was tested by placing successively several layers of metallic foil one upon the other. The action increased as the number of layers was increased, showing that it was not due to a surface effect, but the radiation proceeded from points within the metal.

Determining the Magnetic Moment of a Bar Magnet.

A simple method of determining the magnetic moment of a bar magnet is described by M. H. Armagnat in *La Revue Electrique*. The magnetic field surrounding a straight bar magnet, when measured in the plane perpendicular to its centre, decreases in intensity with increasing distance from the centre of the magnet. The force at any point is given by the equation $F = \frac{M}{(l^2 + x^2)^{\frac{3}{2}}}$, in which M is the magnetic moment, *l* the length of the magnet and *x* the radial distance from the axis of the magnet. If such a magnet be placed in a magnetic field and allowed to orient itself, it will place itself so that the lines due to the field pass along it, and the field immediately surrounding it will be a resultant of the original field and that due to the magnet itself. If a curve be plotted which represents the intensity of the field due to the magnet alone, this curve will represent also the intensity of the resultant field due to the magnet and the external field, if it be displaced a distance equal to the intensity of the external field. This curve will then cross the distance axis at some point, showing that at this point the force changes its direction ; therefore, if a small magnet, such as a pocket compass, be placed at this point, it will behave as though there were no field there. Practically it is hard to obtain such a condition because of the length of the exploring magnet, but it is not difficult to determine the point with fair accuracy by moving the exploring magnet in one direction and in the other, and noting the points at which it takes up definite positions, pointing, of course, in opposite directions. The points sought for will lie between these two positions. The distance from the centre of the magnet having been obtained in this way, the magnetic moment is given by the equation $M = Fd^3$, or $M = Hd^3$, where H is the horizontal component of the earth's magnetism. When the earth's field is employed in the test the value for H can generally be taken from physical tables for the locality where the experiment has been made.



STUDENTS' Section

Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

The Auxiliary-pole Motor.

STUDENTS of all classes will be interested in the auxiliary-pole motors which are now being put on the market in large quantities to fill the need for a machine combining wide speed variation with sparkless commutation. The following abstract from the *Electric Journal* of an article on the subject may be read with considerable profit, as it explains the action of these new motors very clearly:—

Among the various methods in use for controlling motor speed, the simplest and most efficient, as well as the most satisfactory in speed characteristics, is the single-voltage direct-current system in which the variation of the motor speed is obtained by shunt field control. A constant voltage is applied to the motor armature terminals, and a resistance which may be varied in amount is inserted in series with the shunt field of the motor. This resistance is commonly made in the form of a rheostat or simple type of controller. The currents to be controlled in making speed changes are small in value, and, therefore, easily handled. The insertion of resistance in the shunt field circuit varies the strength of the magnetic field, and as the strength of the field is decreased the speed of the motor is increased in direct proportion.

An ordinary shunt-wound motor operating under the above conditions over a speed range of four to one will spark excessively at the brushes unless the motor is rated considerably under its normal capacity. This sparking is due principally to the weakened magnetic field, and to the distortion or shifting of this field due to reaction on it by the field produced by the ampere turns in the armature. When operating a variable-speed motor at the lowest speed with the full strength of field, this distortion does not occur to any marked degree, and the brushes can be set in a position to give sparkless commutation from no-load to a considerable overload. If the brushes are left in this position and the field weakened to give a speed four times the minimum, distortion of the field does occur, and the result is that the neutral point or point of good commutation is shifted so far away from the brush position that the conditions necessary to good commutation are destroyed, and sparking results.

The use of an auxiliary field by correcting this condition produces sparkless commutation and a condition of practical stability of field and consequently of speed in the motor. This auxiliary field is produced by a winding in series with the armature and placed on pole-pieces midway between the main pole-pieces. The best results are obtained by so winding the coils of the auxiliary winding that all of the turns are located as near as possible to the armature surface. This applies the corrective force of the auxiliary winding directly opposite and close to the armature surface, and the field produced by this winding opposes and compensates for the field produced by the armature. The distortion at the point of commutation which would occur if there were no auxiliary winding is in this way prevented by the field produced by the auxiliary winding, and in addition this field assists in reversing the current in the short-

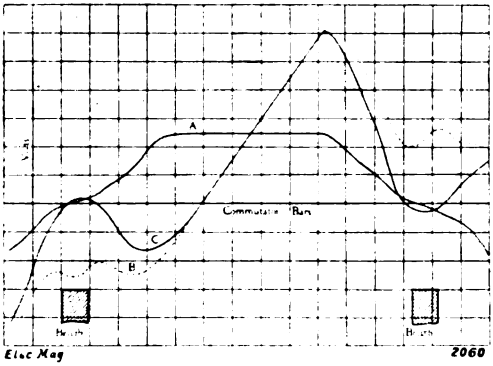


FIG. 1. CURVES SHOWING POTENTIAL DIFFERENCE BETWEEN COMMUTATOR BARS OF SHUNT AND AUXILIARY POLE MOTORS.

circuited coil under the brush. This field being always proportional to the load, the commutation is accomplished sparklessly at all loads up to heavy overloads.

The relations of the fields produced by the shunt winding, the armature and the auxiliary winding, are shown in Fig. 1. These curves or field forms are plotted from measurements taken by running a 5h.p. 400 r.p.m. to 1600 r.p.m. motor at its maximum speed and measuring the potential difference between commutator bars. These readings when plotted with voltage between bars as ordinates, and the commutator bars between positive and negative brushes as abscissæ, give a graphic representation of the shape of the magnetic field. The curves shown were taken under the following conditions: Curve A shows the potential difference between adjacent commutator bars with no load on the motor. It is, therefore, the field form produced by the shunt winding alone. Curve B shows the potential difference between commutator bars of the same motor with full load on the motor but without auxiliary poles or coils; it is, therefore, the field form due to the shunt winding and armature reaction. This curve shows the distortion caused by armature reaction. Curve C shows the potential difference between adjacent commutator bars of the same motor with full load on the motor, but with the motor equipped with auxiliary poles and windings. It is, therefore, the field form due to the combined shunt, armature, and auxiliary windings. By comparing curves B and C it may be seen that the auxiliary winding overcomes the effect of armature reaction at the brushes, and produces a field of the most favourable shape for good commutation. Motors which, when operating under condition shown by curve B, will show vicious sparking at the brushes, will operate sparklessly under the condition shown by curve C. Under these conditions trouble at the commutator practically disappears and the life of the commutator is greatly increased, and perfect reliability of operation assured.

The particular form of winding described above is in reality a compensating winding as well as a winding to produce a commutating field. The effect of armature reaction between the main poles is compensated for, and the actual magnetic flux passing through the auxiliary poles is relatively small. The poles are therefore not saturated, and even at heavy overloads the flux passing through them is proportional to the load.

The efficiency of the auxiliary pole motor is practically constant for a given load at any speed within its range, as the only variable losses are the core loss, friction losses, and field I^2R losses. The core loss and the field I^2R losses increase with increasing speed, and the friction losses increase. The losses thus tend to average up to a constant total giving approximately constant efficiency.

Motors of this type are reversible with no change in setting of brushes or other adjustment. The brushes being fixed in the neutral position, it is only necessary to reverse the current in both auxiliary field and armature to secure exactly similar operating conditions in the reverse as in the forward direction.

One way of making clear the action of the auxiliary pole motor is to consider an auxiliary pole as the pole tip of one of its adjacent main poles. The fringe of magnetic lines under the tip of the main pole piece in an ordinary motor is of great assistance in commutating the armature current. In the auxiliary pole type of motor the auxiliary pole acts as the pole tip of the adjacent pole and the fringe of lines under it is proportional in amount to the strength of the armature current, thus giving an ideal condition for commutation. In reversing the motor, since the current in the auxiliary winding is reversed, the auxiliary pole acts as the tip of the other adjacent main pole. Exactly similar conditions, therefore, prevail for either direction of rotation.

Tests for Armature Faults.

By NORMAN G. MEADE.

It is very desirable to be able to locate faults in motor or generator armatures around shops with simple apparatus that may be on hand. A method which has proven very reliable and requires only a few cells of battery and a telephone receiver is given below.

Test for Open Circuit.—Clean the brushes and commutator, and apply current from a few cells of battery having a telephone receiver in circuit as shown in Fig 1. If the machine has more than two brushes, connect the leads to two adjoining brushes and raise the balance. Now rotate the armature slowly by hand, and there will be a distinct click in the receiver as each segment passes under the brushes until one brush bears on the segment at fault, when the clicking will cease. Note that the brushes must not cover more than a single segment.

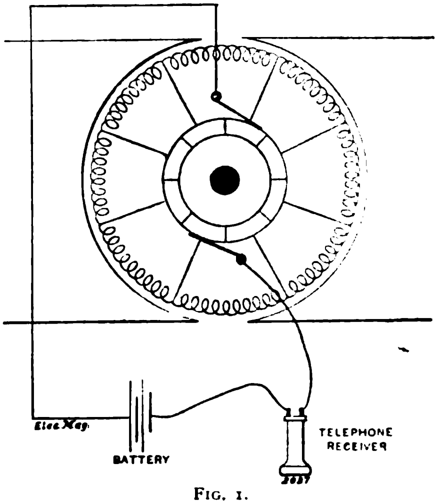


Fig. 1.

If on rotating the armature completely around, the receiver indicates no break in the leads, connect the battery leads directly to the brushes, as shown in Fig. 2, and touch the connections from the receiver to two adjacent bars, working from bar to bar. The clicking should be substantially the same between any two commutator bars; if the clicking suddenly rises in tone between two bars, it is indicative of a high resistance in the coil, or a break (open circuit).

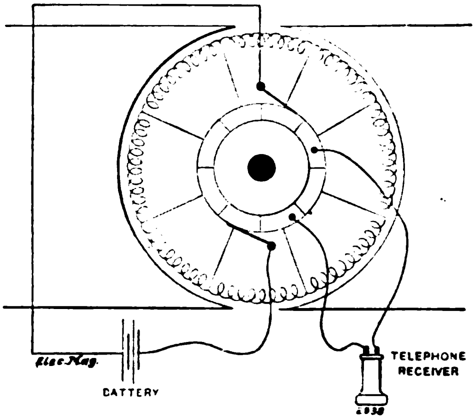


Fig. 2

Test for Short Circuit.—Where two adjacent commutator bars are in contact, or a coil between two segments becomes short-circuited, the bar-to-bar test just described will detect the fault by the telephone receiver remaining silent. If a short circuit is found the leads from the receiver should then include or straddle three commutator bars, as shown in Fig. 3. The normal click will then be twice that between two segments until the coils in fault are reached, when the clicking will be less. When this happens, test each coil for trouble, and if individually they are all right, the trouble is between the two.

Test for Grounded Armature.—Place one terminal of the receiver on the shaft or frame of the machine, and the other on the com-

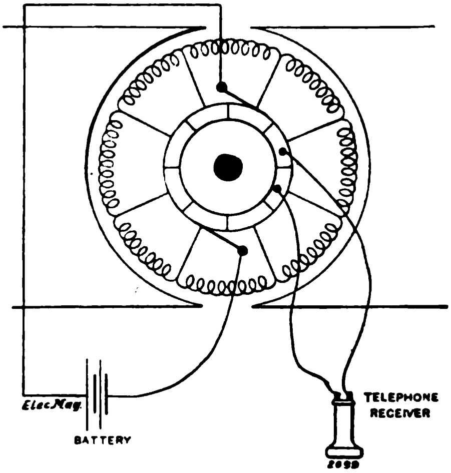


Fig. 3.

mutator. If there is a click it indicates a ground. Move the terminal about the commutator until the least clicking is heard, and at or near that point will be found the contact. Grounds in field coils can be located in the same manner.—*Machinery.*

Polyphase Transformers.

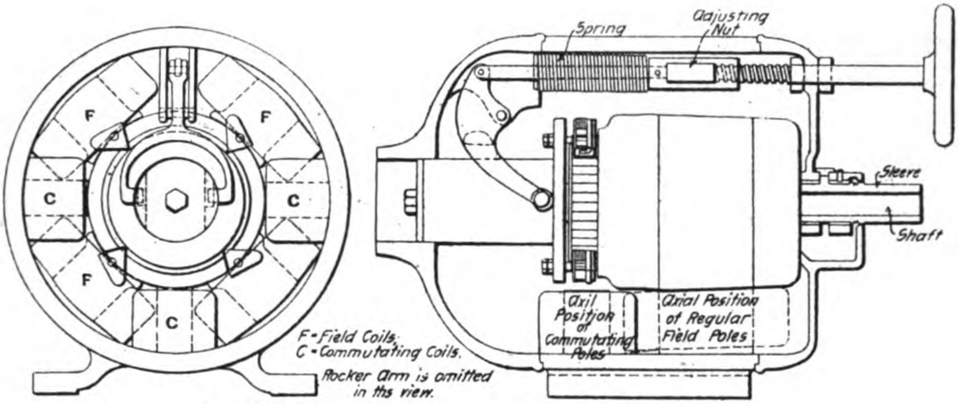
A Question and Answer.

EXPLAIN the difference between delta and star connections in dynamos and transformers, and difference in voltage, with advantages one way has over the other in a three-phase system. Also show where the "1.73" comes from in calculating horse-power.

Ans.—Consider three transformers, the terminals of the first being numbered 1 and 2; the second 3 and 4; and the third 5 and 6. In the delta connection, terminal 1 is connected to terminal 6, terminal 2 is connected to terminal 3, and terminal 4 is connected to terminal 5. In the star or "Y" connection, terminals 2, 4 and 6 are connected together, and terminals 1, 3 and 5 connected to the three outgoing lines. In the delta connection, the three outgoing lines are connected to the junctions between terminals 1 and 6, 2 and 3, and 4 and 5. In small plants the delta connection is almost invariably used, inasmuch as one transformer can be disconnected, and still three-phase transformation can be made with the other two transformers with their original connections. In the case of the star system, if one transformer is damaged this will cut the other two out of service. However, in large plants, where there are a great number of groups of transformers, and the line voltage is very high, the star connection is usually used, for the damaging of one set of transformers will mean slightly reduced capacity but not a complete shut down. With the delta connection, the full-line voltage is across each transformer, and consequently each transformer has to be insulated for the line potential. With the star connection, however, the voltage across each transformer is only 58 per cent. of the line voltage, and consequentially where very high potentials are used, the "Y" connection allows a mechanically smaller transformer to be constructed, as less insulation is needed. The constant "1.73" is not used in calculating horse-power, but rather in the figuring of the ratio between the current in any one line of a three-phase system, and the total current in the three lines. If the current in each of the three lines is the same, then any one line multiplied by 1.73 equals the total current in the three lines. The derivation of this constant is as follows: A three-phase delta connected machine practically consists of three single-phase windings, the current in each of these windings being one-third of the total current in the machine, assuming, of course, that the current in each winding is the same. If this energy were transmitted over three distinct single-phase lines, each line would have flowing in it one-third of the total current, but this method, as you are aware, is not the practice. The ends of the three single-phase windings are connected, as explained above, and one wire is run out from each of these connections. Therefore each of these wires will carry the current generated in one phase and the current generated in the adjacent connected phase. Assume, for the sake of argument, that the value of the current in each of these phases is equal to 1. From this it might be implied that the sum of two currents was equal to two, but this is not the case, inasmuch as the angle of the two currents differs 120deg. The resultant of these two currents, each equal to one, and 120deg. apart, is equal to 1.73. Now, the sum of the three currents is equal to three, while the current in each wire is equal to 1.73. The square of 1.73 is also equal to 3, and therefore if the current in any one wire be multiplied by the constant 1.73, the product is the total current of the system.—*Canadian Electrical News.*

A New Variable Speed Motor.

THE observant student who keeps in touch with the latest electrical developments will know that during the past few months many different types of variable speed motors for direct currents have been put on the market. Among these the interpole motor will be familiar to him, and in this section we draw further attention to this interesting type of machine this month. It represents a design in which speed variation is made possible by the electromagnet means provided to overcome excessive sparking and counteract the armature reactance voltage. Other motors have been built in which the


Spring
Adjusting Nut
Sleeve
Shaft
F
F
F
C
C
C
Axil Position of Commutating Poles
Axial Position of Regular Field Poles
F - Field Coils.
C - Commutating Coils.
Rocker Arm is omitted in this view.

End View and Side Section through Variable Speed Motor.

field system is mechanically moved and direct speed variation obtained without electrical regulation in any form. In one type the poles are withdrawn radially and uniformly from the periphery of the armature.

The latest machine of this kind provides for the transverse movement of the armature from the influence of the field, and the arrangement adopted is shown in the illustration on this page.

Motors with speed ranges up to 10 to 1 are regularly built. The withdrawal of the armature from the influence of the field poles decreases the field area and magnetic flux, increases the air gap and resistance, and therefore increases the speed. The conical armature used, by a more rapid increase in the air gap, gives a greater increase in speed for a given lateral adjustment than is possible with a cylindrical armature. The horse-power of the motor is uniform, the torque varying inversely with the revolutions per minute.

To accomplish this, there has been perfected a thrust bearing which supports the commutator end of the armature, carrying an annular ball bearing to take both thrust and radial loads. This thrust bearing is actuated by a split lever having a central pull on opposite sides of the thrust bearing. Movement of the lever is accomplished by means of a screw mechanism and hand wheel, a spring around the lever connecting-rod being adjusted to balance the magnetic pull of the armature. The motor is a two-wire direct-current shunt-wound type, the same as any ordinary direct-current machine so far as installation is concerned.

The system admits of speed variation inside the motor, doing away with the electric controller with its complicated wiring, necessary to the ordinary method of speed variation by field weakening, and the necessity of finding room for its accompanying resistance. The speed variation is under the immediate control of the machinist, who with his eye on the tool and his hand on the regulating wheel can immediately increase or decrease the speed. Gradually he can increase the cutting speed up to what the work will stand, or with work of varying diameter keep his cut at the maximum speed throughout, without the abrupt changes liable to occur where a controller is used. It is so easily accomplished that it is claimed that a careful workman will make an involuntary saving on his product of 10 to 30 per cent. of the labour cost.

The efficiency is claimed to be high, comparing favourably with good constant-speed motors. Efficiency at full load on a 5h.p. 5 to 1 motor is said to show by test from 86 per cent. at 300 r.p.m. to 75 per cent. at 1500 r.p.m. Of quite as much if not more importance is the statement that it compares very favourably with good constant-speed motor practice in the maintenance of any given speed under varying load conditions —which is impossible with the ordinary method of field weakening by controller.

The perfection of this motor was attended with more than ordinary difficulty. Every feature was tested and tried for requisite efficiency before the motor was placed on the market. The makers claim that the motor will run in either direction with equal results. This is an important point of merit. A simple reversing switch is all that is required.

Individual Drive v. Group Drive.

AN enquirer in *Canadian Machinery* asks, What are the considerations to be taken into account when deciding whether individual drive for an ordinary sized repair and job machine shop would be more or less suitable than group drive by shafting from one motor?

Our contemporary makes the following answer, which will be found instructive to students:—The consideration must involve cost and efficiency. Let us first consider cost. Under this head would come the first cost of the installation, and also the relative costs of operating under the two systems. The relation between the first cost and the difference in the operating expenses can be computed fairly accurately, and will be a decided factor in the choice of the two systems. The relative efficiencies of the two systems to perform the work required cannot be computed in figures very readily, but for all that should be given careful consideration.

In order to reckon with definite quantities to some extent let us consider a machine shop containing 9 machine tools, consisting of 3 lathes, 1 planer, 2 drills, 1 shaper, 1 miller, and 1 boring mill, besides a hack saw, emery wheel, &c., which might be regarded as taking power equal to 1 machine tool. Now let us suppose that the average power used by each machine, when engaged on ordinary work, is 1h.p. Then 10h p. would be the amount taken by the machines.

From tests made it has been found that the per cent. of power required to run shafting varies from about 14 per cent. to 80 per cent. of the total load. Probably for machine shops from 30 to 40 per cent. would be an average figure, and here calculations will be made on the basis of 30 per cent. Then 70 per cent. of total load is delivered to the machines. Thus in our assumed case $\frac{100}{70} \times \frac{10}{1} = 14\frac{2}{7}$h.p. is the full load on the motor when all the machines are running. Although it is very seldom that all the tools would be running at the same time, the motor should have a rated horse-power of that amount, so as not to endanger its coils by running under a continuous overload. Then let us allow for probable shop extensions by installing a 16h.p. motor.

Probably in the average machine shop we shall find that one-half the tools are operating continuously under full load. That is, in this case 5h.p. will be delivered by the shafting continuously. However, 30 per cent. of full load, or 4 2-7h.p., is required by the shafting. Thus the motor will be supplying 9 2-7h.p. Now, the efficiency of a 16h.p. motor is at best between 85 and 90 per cent., let us say 88 per cent. When running under a load of 9 2-7h.p. the deficiency would be decreased to about 86 per cent. Thus the motor would be taking from the mains $\frac{100}{86} \times \frac{65}{7} = 10.8$h.p.

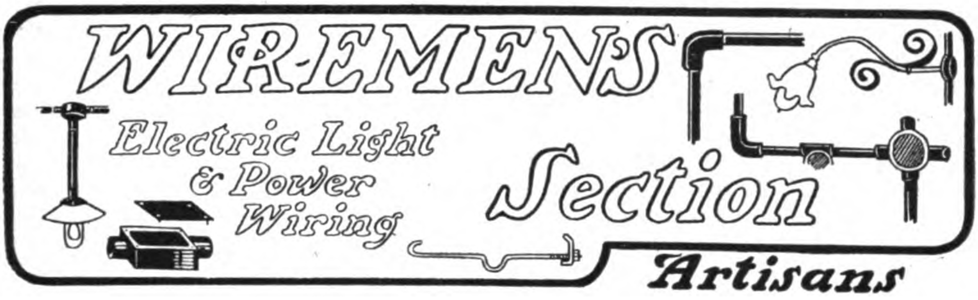
Now, let us consider the alternative method of having each machine motor driven. As we assumed in the foregoing, considering five of the machines are running continuously, and still assuming that the average horse-power of the machines is 1, there will be 5h.p. used by the machines. The efficiency of a 1h.p. motor is about, 72 per cent., and since the load on each is fairly constant, the efficiency does not vary. Thus the power taken from the mains is $\frac{100}{72} \times \frac{5}{1} = 6.9$h.p.

Comparing these figures with those obtained in the first case, we find that there is a saving of $10.8 - 6.9 = 3.9$h.p. Considering the requirements of the two cases, there is in the one the 16h.p. motor and rheostat, together with the shafting and belting necessary for transmission; and in the other there are the 11 small motors with rheostat for each, together with extra wiring.

Now, if the cost of the 3.9h.p. saved is sufficient to pay interest on the extra amount invested for individual drive equal to the per cent. profit got from the business, the two systems are on an equal footing as far as actual costs go.

However, consideration should be given to the relative value of the systems from the standpoint of convenience in handling and operating the tools, &c. The first cost is not the only factor, and in many cases should not be the most important one.

The horse-power is equal to 746 watts of $\frac{1000}{746}$kw., the system of units in which electrical energy is sold.



System in Wiring Work.

ONE has only to walk casually through a building being wired for electric light to realize how unsystematic the average wireman is in his methods. In this branch of electrical work there is more need for system than in any other, and the following "pointers" on how to remedy the existing state of affairs should be carefully studied by our wiremen readers. They are taken from an article contributed to the *Electrical Engineer* by a writer who signs himself N.O.R.A. "The most important point is to secure, not cheap men, but good methodical men, capable of leaving a clean firm job after them. Hundreds of men will never get beyond the detail stage, but always providing they are capable of this, they are of as much value to an employer on simple wiring work as a man who can take control. Men of this class owing to their being confined to strictly practical work, usually acquire more skill in the handling of material. It is important to have all material promptly sent on the job when required, as it is not unusual to have to find work for men elsewhere pending the arrival of some particular size tubing, junction boxes, &c. A duplicate order book hung up in the stores or office will work wonders in this respect. These orders when written out by workmen should be placed before the master, who in turn orders the materials, if required, or sees they are promptly supplied if in stock.

"There is such a thing even in wiring work as an artistic way of finishing off a job. A gross or so of wood bushings, some half normal bends to use instead of setting piping, some decent shades and lamps, in the principal positions, more than repay for themselves in time. Recognise the importance of labour-saving devices. The writer recently had to deal with a large screwed-tubing job, and stocks and dies were supplied for screw cutting as a machine was put down as too costly an investment. The larger sizes of piping took at least thirty minutes to thread, cut, and file, and then with two men turning the stocks. The time represented by all this labour was no small item, and if reckoned up would probably more than equal the cost of a screwing and cutting machine. The machine would also leave a cleaner thread on such tubing, thus leading to a sounder job.

"A charge hand should always know exactly what material he has at command. There is one abomination beloved in particular of lazy wiremen. This is a large box which originally contained material consigned direct to the job. If a holder will not screw up nicely or a coil of flex becomes tangled it is forthwith consigned to the tender care of this box. Then a chaotic mixture of ceiling roses without covers, screws, nails, tape, augers, bottles, and overalls fills that box. If apprentices are available—not the hundred-guinea sort, but some likely lads who can be sacked without delay if they start throwing their weight about—get one of these individuals to keep a weather eye on the material. Make him keep it together in one room and see it is properly sorted out when returning for credit. Screws are another source of trouble. Workmen should be supplied with the exact gauge required. On account of the difficulty in getting a screw-driver into the slot of a round head capping screw nine out of ten wiremen hammer them in all the way. Flat head screws are sometimes hammered also, when nobody is looking, but any decent workman will, even if he does use a hammer, give his screws a twist or two to tighten them up thoroughly.

"A good system of timekeeping is essential where there are a number of men employed. Perhaps the best all-round system for wiring firms would be to have all workmen call to stores or office at eight o'clock or whatever hour the day starts at. If a time-recording clock is not installed, the time book may be ruled off in columns: "Time, name, job, tram tickets, remarks." Thus it may be at any time possible to find any particular man if required. Advantage should be taken of the morning call of the workmen to get them to make out daily time sheets, or to fill the previous day or a weekly time sheet kept in the shop. Men should be supplied with tram tickets for distant jobs, and as the average being is in no hurry to work after signing his time that morning the rubber stamp of the firm should be applied to each ticket. If this is done the tickets are almost always used as intended.

"In every town there is usually to be found a plentiful supply of wasters. They are occasionally referred to as 'sons of rest.' The golden rule is to keep this species as far as possible from the premises. There is a story going to the effect that one of this fraternity was taken on by a contractor and sent alone to wire a small house in the suburbs. The governor, looking in a day or so after, was pleased to find almost the whole house wired to points by the new man. It was not discovered until he had drawn his week's wages and disappeared (a 30s. galvanometer disappeared too), he had just pushed an auger through the ceilings and inserted some pieces of 3/22 with a knob on the other end to pull tight."

Motors for Machine Tools.

THE application of individual motor-drive would require a somewhat different consideration for each machine tool, says *Canadian Machinery* in answering a query on the subject, although in the main it would be the same. As a good example the application of a variable speed d.c. motor, multi-voltage control, to an engine lathe will be here considered. It is desirable to get as much work out of a lathe as the tool steel and the lathe itself will stand, and thus the first thing to be determined is the speed range that can be obtained at the spindle as the lathe stands, and then the new range of speeds desired. The new range of speeds will depend upon the work to be done, upon the tool steel used, and upon the strength of the lathe. What the tool will stand on certain materials and with certain tool steel and spindle speed is best determined by actual test. The minimum speed would be for the heaviest cut of the largest diameter of work, while the maximum speed will be the lightest cut, or for filing, on the smallest diameter of work.

Having determined the speeds the next thing required is the horse-power, and this depends almost directly upon the amount of metal removed. A much-used formula for this purpose is:

H.P. = feed × cutting speed in inches per min. × number of cutting tools × a constant.

This constant varies, of course, with material. An extensive series of tests made by the Crocker-Wheeler Co. show the value of this constant to be from 0.35 to 0.5 for cast iron, and from 0.45 to 0.7 for steel, depending upon the hardness of each metal. Perhaps for a good safety factor it would be well to assume these constants somewhat higher than here given, and then should an extra hard piece of metal be struck it would be assured that motor was not running under too great an overload.

A good example of the application of a variable speed d.c. motor, multi-voltage control, is had in the machine shop of the Pittsburg and Lake Erie Railway. Recently the entire tool equipment of this shop was changed from mechanical to electrical drive under the supervision of their mechanical engineer, R. V. Wright. The application of a motor to a 20in. Reid lathe, as installed by Mr. Wright, will be here taken as a concrete example.

The intermediate speeds between any two voltages were obtained by changing the resistance in the armature of the motor, and the controller used as a Crocker-Wheeler M.A. 12. The range of speeds of from 8 to 240 revolutions per minute were required upon this tool. The class of work to be done being heavy, it was decided to fit it up with a capacity of a ¼in. cut with a 1-32in. feed on hard steel at a cutting speed of 50ft. per minute. The horse-power required to do this work = 1-32 × ¼ × 50 × 12 × 1 × 0.7 = 3.28 horse-power, according to the formula and the steel constant given above. The back gear ratio was 10.1 to 1 in the lathe as it stood. The engineer considered and solved the problem in the following manner, as described by himself:

Assume the motor to be connected so as to drive the main spindle at 240 revolutions per minute. Now, if the back gear is thrown in, the spindle speed will be 240 ÷ 10.7 = 22.4 revolutions per minute. In order to fill in the gap between 25 and 240 revolutions per minute the motor would be required to have a speed range of about 9.6 to 1. It would be found that when the motor is running at 1-9.6 of its maximum speed, the lowest speed, it will furnish about 20 per cent. of its rated power. Therefore, in order to furnish 3h.p. throughout the range, a 15h.p. motor would be required. A motor of that size would be bulky for a 20in. lathe, nor would it be efficient at the lower speeds.

It was then considered whether with the required power and speed range a smaller motor might not be used by changing the number of teeth in the gears. Two hundred and forty to eight revolutions per minute is a range of 30 to 1. For such a range the motor and the run of gearing would each have to cover a range of speed of about 5.5 to 1. It will be found that the motor when running at 1-5.5 of its maximum speed furnishes practically the same per cent. of power as in the case considered above. The advisability of adding another run of gears was considered. The motor and each run of gears would then be required to have a range equal to the cube root of 30, or about 3.108 to 1. The spindle speeds would run thus:

	Maximum.	Minimum.
First run	240	77.3
Second run ...	77.3	24.9
Third run ...	24.9	8.0

It would be just as well, however, if there were a jump of speed between the different runs of gearing equal to the 10 per cent. speed increments furnished by the controller. Reduce the speed range of the motor 10 per cent., or from 3.108 to 1 down to 2.79 to 1, and the spindle speeds will run thus:

	Maximum.	Minimum.
First run	240	86
Second run ...	77.3	27.8
Third run ...	24.9	8.93

The lower speed limit is increased somewhat, but this can easily be remedied by changing the ratios slightly. The motor could, of course, be run at a still lower speed, but at reduced power.

It will be found that when the motor is running at 1-2.79 of its maximum speed it furnishes 60 per cent. of its power. Therefore, in order to have a 3h.p. available throughout the range a 5h.p. motor will have to be used. At controller point 10, 11 and 12, it will run a little below 3h.p., but the motor will run at full power at these points a small part of the time only, and it can easily take care of the slight overrun.

The Contractor's Soliloquy.

"To cut or not to cut, that is the question—
Whether 'tis not better in the end
To let the chap who knows not the worth
Have the work at cut-throat price, or
To take up arms against his competition
And, by opposing cut for cut, end it.
To cut, and, by cutting, put the other cutter
Out of business; 'tis a consummation
Devoutly to be wished. To cut, to slash,
Perchance myself to get it in the neck—
Ay, there's the rub; for when one starts
To meet the other fellow's price, 'tis like as not
He's up against it good and hard.
To cut and slash is not to end confusion
And the many evils the trade is pestered with;
Nay, nay, Pauline; 'tis but the forerunner
Of debt and mortgage such a course portends.
'Tis well to get the price the work is worth
And not be bullied into doing it
For what So-and-So will do it for.
Price cutting doth appear unseemly
And fit only for the man who knows not
What his work is worth, and who, ere long,
By every stress of making vain comparison
'Twixt bank account and liabilities,
Will make his exit from the business."

—From the *Electrical Contractor.*

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"The Slide Rule."

By C. N. PICKWORTH. Manchester: Emmott & Co., Ltd., 65, King Street. Price 2s.

Electrical engineers who do not use the slide rule should remedy the deficiency without delay. That invaluable accessory is now cheap enough, and so also is a compendium of information how to use it, more especially in the little book now before us. The fact that Mr. Pickworth's work is in its tenth edition conveys succinctly all the praise we need give or the eulogies we may write upon its value. Any enthusiast of the slide rule will recommend the volume as the standard pronouncement on the subject. The explanations are lucidity itself, and a careful study of the examples given will convert the merest tyro into an expert manipulator of the engineer's greatest time-saving device.

"The Principles of Electric Wave Telegraphy."

By J. A. FLEMING, M.A., D.Sc., F.R.S. 1906. London: Longmans, Green & Co, 39, Paternoster Row. Price 24s.

Any book by Dr. Fleming is always both eagerly looked for, and as eagerly read. Moreover, unlike many technical books, Dr. Fleming's works go at once to the "standard" shelf in the bookcase and remain there. For several years past the labours of this eminent scientist in the wireless telegraph field have been productive of the most encouraging results, and it is to be expected that the continued pursuit of these will greatly advance our knowledge of this comparatively new branch of electrical development. The volume now before us, and which is but just off the press, is the most exhaustive treatise on wireless telegraphy we have yet seen, and in a near issue we shall review it in detail. At the moment we think it desirable that our readers should know of this book, and also that, although its price is higher than books of its class, the historical matter is most comprehensive and carefully classified, while in addition all the results of Dr. Fleming's researches are embodied in the principles, with which he deals at great length.

"Fire Tests with Floors."

1906. London. The British Fire Prevention Committee, 1, Waterloo Place, Pall Mall.

The use of so-called fire-proof construction material has increased so much of late years that station engineers who undertake the consulting work for their own undertakings cannot fail to be interested in the Red Books of the British Fire Prevention Committee. The investigations of this committee are of the most valuable character, and the possession of its reports in Red Book form may save an engineer many thousands of pounds. The book before us is number 109 and deals with a fire test of a floor of concrete and expanded metal construction. In a prefatory note to the report, Mr. Max Clarke, directing member of the sub-committee conducting the test, states, with regard to the floor tested, that "this form of construction is engaging the attention of scientific men in different parts of the world, and it appears to me that large allowances will have to be made for faulty or careless construction in addition to the usual margin of safety. Only the practical results given by time and accident will answer these questions fully, but they should not be overlooked by those who advocate a new departure in this direction." The report is illustrated with excellent photographs and diagrams.

"Modern Polyphase Machinery."

By ANDREW STEWART. 1906. London. S. Rentell and Co., Ltd., 36, Maiden Lane, W.C. Price 5s.

Mr. Stewart has written not a little on the practical aspect of electrical engineering, and we believe his books are much appreciated. In his latest work his task has been more arduous than heretofore, but he has none the less done it well. His object was to deal with polyphase currents and apparatus from a non-mathematical and practical point of view, and he has, we think, succeeded. We must confess, however, that neither the printer nor draughtsman has done justice in the drawings and type to his efforts at lucidity in the text. The book is not well printed, and the diagrams are poorly drawn. This is apparent from the first page, and does not improve as one proceeds through the book. The ground covered is most extensive, as may be gathered from the fact that there are 24 chapters in the book. The first fourteen of these bear on the theory of the subject, though in a manner readily understandable by the ordinary reader. Certain portions of this matter might with advantage be reduced, as it may be considered superfluous by the practical reader. In particular, we refer to chapters nine to twelve inclusive. A great deal more might have been said on the testing of alternators and motors, the two chapters given being much too short for so important a subject. The book as a whole will be found useful, but its price will restrict its sale, especially as the general get-up is poor and not in keeping with the charge made for the book.

"Einführung in die Thermodynamik."

("Introduction to Thermodynamics.") By Dr. J. MEYER. Halle a. S.: W. Knapp, 1905. Price M. 8.

Few subjects present so much difficulty to beginners as thermodynamics. It is to be feared that in the minds of many students the term is synonymous with an unintelligible collection of mathematical symbols, connected in some way with a mysterious entity known as entropy, whose exact meaning, however, they are convinced nobody quite understands. This attitude is no doubt due partly to the inherent difficulty of the subject, partly to the absence—until quite recently—of thoroughly satisfactory text-books on it. The volume under review should go a long way towards smoothing the path of the beginner. It is certainly one of the clearest and most readable expositions of this difficult subject which we have come across, and we can strongly recommend it to all who desire to acquire a sound knowledge of it, but who do not possess the mathematical training which would enable them to read any of the more advanced treatises. A brief account of the contents of the work may be given. After a mathematical introduction, the author deals in Section I. with calorimetry, thermometry, the state equation, and thermodynamic coefficients. The First Law and its applications are considered in Section II. The next section is devoted to the Second Law, reversible cycles, entropy, absolute temperature, thermodynamic potentials, conditions of equilibrium, and phase theory. The concluding section, IV., deals with free energy, dilute solutions, law of mass action, electric energy, &c.

"Steam Turbine Engineering."

By T. STEVENS and H. M. HOBART. 1906. London. Whittaker and Co., Paternoster Square. Price 21s.

Any station engineer who reads the preface to this work should at once be attracted to it. The authors state that it "relates to a consideration of the subject from the standpoint of purchaser and user," and this should at once assure the central station man that this is the book for him. The steam turbine has established itself in engineering circles, and a greater knowledge of its construction and performance is at once desirable. Messrs. Stevens and Hobart's work essays to cover the present field of steam turbine engineering, and after an examination of its pages we can confidently say they have faithfully carried out the task. Ten different types of turbines are considered in detail in separate chapters, these being the de Laval, Parsons, Curtis, Rateau, Zoelly, Riedler-Stumpf, A.E.G., Hamilton-Holzwarth, Elektra, and the Union. Each chapter contains an exhaustive description of the particular machine dealt with, and is profusely illustrated with photo reproductions and drawings. These occupy the greater part of the work, and are followed by excellent and valuable chapters on the properties of steam, calorific value of fuels, steam economy in modern piston engines, steam turbines and piston engines compared, steam pressure, superheat and vacuum, condensers, foundations and buildings. The book contains an almost bewildering number of curves, many of which are very small and situated some distance from the references to them in the text. A quite unnecessary amount of space seems to us to have been allotted to examples of steam turbine plants, the method of classifying the respective parts being somewhat confusing. A table of details is started on one page and continued some thirty or more pages forward. The classification adopted is certainly convenient, but we doubt whether engineers would go to the trouble of employing it for purposes of comparison. Again, the installation descriptions include views of switchgear and diagrams which seem rather out of place in a work on steam turbines. With these few exceptions, we have nothing but praise to give to the compilation of data which cannot fail to fill a long-felt want in the literature of the subject. One important feature we must not overlook, and this is a complete bibliography of literary contributions on steam turbines, super-heated steam, condensing plant, and marine installations, which have been published since 1896.

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Fly-wheel Accident at Mansfield, Ohio.	*Westn. Electn.* 19/5/06.
Stanley's System of Transmitting and Utilizing Low-frequency Currents.	*Westn. Electn.* 19/5/06.
Hydro-Electric Developments at Trenton Falls, N.Y.	*Elec. Wld.*, 19/5/06.
Electrical Equipment of New Engineers' Club Building, N.Y.	*Elec. Wld.*, 19/5/06.
A Japanese Steam Turbine Electric Station.	*Elec. Wld.*, 12/5/06.
First Report of Hydro-Electric Power Commission.	*Canad. Elec. News* *May*, /06.
Hydro-Electric Development of the Vancouver Power Co.	*Canad. Elec. News* *May*, /06.
Some Fallacies Regarding Rope Transmission. G. F. Willis.	*Power, May*, /06.
Design, Construction, and Application of Large Gas Engines in Europe. F. E. Junge.	*Power, May*, /06.

Traction.

Articles.

New Cars of South Side Elevated, Chicago.	*Str. Rly. Jrnl.* 19/5/06.
Electrification of West Shore Railway between Utica and Syracuse.	*Str. Rly. Jrnl.* 19/5/06.
Tabulation of Traffic Statistics in Berlin. A. Stavenov.	*Str. Rly. Jrnl.* 19/5/06.
Single-Phase Railway for the Milan Exhibition, 1906. E. Fumero.	*Elec.* 11/5/06.
The Galveston Grade Raising from the Street Railway Point of View. H. S. Cooper.	*Strt. Rly. Jrnl.* 12/5/06.
Trackless Trolley between Spezzia and Portovere, Italy.	*Str. Rly. Jrnl.* 12/5/06.

Central Station Practice.

Articles.

Causes and Prevention of Faults on Direct Current Networks F. Fernie.	*Electrician.* 11/5/06.
Methods of Metering for Electric Supply. R. Hornby.	*Elec. Rev.*, 25/5/06.
Electricity and Gas *v.* Smoke. C. A. Smith.	*Elec. Rev.*, 25/5/06.
Electricity *v.* Gas in Glasgow.	*Elec. Eng.*, 18/5/06.
Electricity *v.* Gas in Newcastle.	*Elec. Eng.*, 1/6/06.
Compounding of Rotary Converters.	*Canad. Elec. News*, *May*, /06.
Installation and Maintenance of a Small Electric Light Plant.	*Power, May*, /06.
Boiler Corrosion and other Faults. W. H. Booth.	*Power, May*, /06.
Oil Required for Lubrication. C. W. Bain.	*Elec. Wld.*, *May*, /06.
The Over-advised Central Station, Manager, J. C. Hammond.	*Elec. Wld.*, *May*, /06.

Papers.

Regulation of Discharge Pressure of Lighting Batteries. E. P. Hollis and E. R. Alexander.	*Newcastle I.E.G.*, 14/5/06.
General Supply of Electricity for Power and other Purposes. Its Commercial Character and Controlling Management. J. N. Shoolbred.	*Society of Arts*, 23/5/06.

Lighting and Heating.

Articles.

Electricity at the New York Hippodrome.	*Elec. Wld.*, *May*, /06.
Distribution of Illumination in the Neighbourhood of Two Lamps. J. R. Benton.	*Elec. Wld.*, *May*, /06.
The Lighting of Desks. J. R. Cravath and V. R. Lansingh.	*Elec. Wld.*, *May*, /06.

Papers.

A Method of Street Lighting by Incandescent Lamps. W. Underwood and V. R. Lansingh.	*N. Y. Ill., Soc. Eng.*, 11/5/06.
High Efficiency Incandescent Lamps for Street Lighting. W. F. Wilcox.	*N. Y. Ill., Soc. Eng.*, 11/5/06.

Telegraphy and Telephony.

Articles.

The Last Link of the All-American Cable. L. G. Martin.	*Elec. Rev., N.Y.* 19/5/06.
A Telephone Relay. J. Trowbridge.	*Amer. Jrnl. Sci.* *May*, /06.
A.C. Signal Circuits in New York Subway. J. M. Waldron.	*Western Electn.* 19/5/06.
A Modification of the Cable Zero Conductor Resistance Test for Submarine Cables. G. B. Winkfield.	*Electrician*, 25/5/06.
On Directed Wireless Telegraphy. F. Braun.	*Electrician*, 25/5/06.
Wireless Telegraphy. R. A. Fessenden.	*Elec. Rev.*, 11/5/06.
Commercial Aspect of Wireless Telegraphy. E. Edser.	*Elec. Eng.*, 1/6/06.
Some Ideas of Telephone Currents. G. W. Wilder.	*Sound Waves.* *May*, /06.
Interior Telephone Systems. C. H. Coar.	*Sound Waves*, *May*, /06.
Construction of the Ideal Exchange. G. J. Newton.	*Sound Waves*, *May*, /06.
Wireless Telegraphy on Sea-Going Steamships. A. Gradenwitz.	*Teleg. Age.* 16/5/06.
San Francisco Telegraph Office in 1880. J. W. Hayes.	*Teleg. Age.* 16/5/06.

Electrical Design and Manufacture.

Articles.

A Résumé of Electrical Resonance. F. F. Fowle.	*Elec. Rev., N.Y.* 19/5/06.
Three to Six Phase Transformation and Connections to Rotary Converters. G. J. Reynolds.	*Elec. Wld.*, 19/5/06.
Classification of Alternate Current Motors. V. A. Fynn.	*Electrician*, 25/5/06.
Mechanical Design of Commutators for Direct Current Generators. R. Livingstone.	*Electrician.* 18, 25/5/06.

Electro-Chemistry.

Papers.

Instructive Laboratory Experiment in Applied Electro-Chemistry. W. H. Walker.	*Amer. Elec. Chem. Soc.* 3/5/06.
Electrolyte Density in Storage Cells. W. L. Lyndon.	*Amer. Elec. Chem. Soc.* 3/5/06.
Electro Chemical Processes as Station Load Equalizers. E. A. Sperry.	*Amer. Elec. Chem. Soc.* 3/5/06.
The Electric Vacuum Furnace. W. C. Arsem.	*Amer. Elec. Chem. Soc.* 3/5/06.
Electrolytic Corrosion of Copper-Tin Alloys. B. E. Curry.	*Amer. Elec. Chem. Soc.* 3/5/06.
Electrolytic Corrosion of Structural Steel. M. Toch.	*Amer. Elec. Chem. Soc.* 3/5/06.
Development of the Nickel-Plating Industry. I. Adams.	*Amer. Elec. Chem. Soc.* 3/5/06.
Errors in Pyrometry. B. E. S. Shepard.	*Amer. Elec. Chem. Soc.* 3/5/06.

Students.

Articles.

Re-winding Dynamo Electrical Machinery. N. G. Meade.	*Power, May*, /06.
Suggestions for Erecting Engineers.	*Power, May*, /06.
Elementary Lectures on Electrical Engineering.	*Power, May*, /06.
Practical Installation of Electrical Apparatus. T. W. Poppe.	*Elec. World*, *May*, /06.

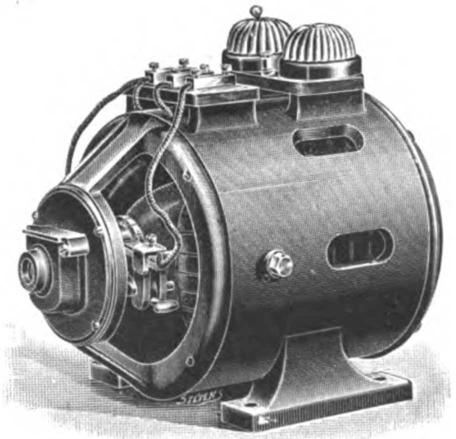
MANUFACTURING Progress

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Rotary Transformers.

The great increase in the number of small batteries for ignition purposes for motor-cars and smaller vehicles has created a demand for continuous current for charging purposes in all parts of the country. As many of the British central stations are supplied with alternating current, unless special provision for transformation to direct current is made, those traders who are in a position to receive accumulators for charging cannot do business because only alternating current is available. In many cases a small gas or oil dynamo is put down, but the starting and running of these are likely to be troublesome, and something much more simple is to be preferred.

During the past few years a number of small rotary transformers have been put on the market, and in the majority of cases have proved very popular to meet the conditions outlined above. The Crypto Electrical Company especially has done a great deal to develop this type of dynamo electric machine. It has recently produced an exceedingly compact form of rotary transformer, which takes up much less room than an earlier machine which was designed by the company for transforming alternating to continuous current. The older machine had two pairs of bearings, but in the latest form these have been reduced by one-half, with the result that the overall length of the machine is now fifteen inches instead of twenty-five. It will be seen from the illustration of the machine, which we are able to reproduce by the courtesy of the company, that the field systems of both the alternate motor and continuous current dynamo are contained within one carcase supported by two feet, by which the machine can be bolted down to the floor. The dimensions of the machine clearly indicate that it occupies a minimum of space, and has been designed upon very close lines. The length over the shaft is 15in., the height 13in., and the width only 11in. As the machine requires no external energy to drive it, it can be placed in a corner or even on a bracket, as it only weighs 72lbs., and will run constantly with practically no attention. We understand that the primary side can be wound for any voltage or periodicity on single, two, or three phase mains, and the secondary has an output of 100 watts, and is usually wound for 15 volts, and a current of from six to seven amperes. With this capacity available it is possible to charge nine motor bicycle ignition sets, at a



Crypto Electrical Company's New A.C.-D.C Rotary Transformer.

any abnormal condition of the circuit which tends to actuate the tripping coils. The main contacts of the switch, which are under oil, are of an improved design which affords very efficient electrical contact. A feature of the setting of these contacts is that, in addition to the usual flexible connections and springs, each contact block is free to rock about a central point so that it automatically adjusts itself to the exact angle of the rising contact block, which will give a maximum of contact surface. The switches are manufactured in standard sizes for voltages varying between 400 and 6000, and for capacity from 100 amperes per phase to 1200.

New Catalogues

Any of the firms mentioned below will forward the literature reviewed under this heading on receipt of a post-card request for same.

Electric Light Supplies.—G. BRAULIK, Upper Thames Street, London, E.C. Mr. Braulik has just sent us section L of his general catalogue, and this is one of the early comers among business literature for the season 1906-7. It is a compilation of nearly 130 pages devoted to arc lamps, fittings, accessories, distribution bars, main switches, incandescent lamps, and small motors and accumulators. The illustrations are very clear, and among the apparatus mentioned will be found a number of new and interesting specialities. We strongly recommend all persons interested to apply to Mr. Braulik at once for a copy of this list.

Ship Installations.—CLARKE, CHAPMAN, AND CO., LTD., Gateshead. On another page of this section we devote a few remarks to the work of Clarke, Chapman, & Co., with electric installations in the Navy and mercantile marine. A complete list of these containing full details is given in an excellent catalogue which has just come to hand. It is provided with a very attractive cover, and the numerous illustrations are all very well reproduced. The bulk of the production is given up to a list of vessels which have been fitted by the firm, and this in itself is an excellent testimony to the amount of business done in this direction. We think, however, it would have been an improvement if a few totals from the lists had been made up, as some respectable figures would then have been presented to the reader, and indicated to him in a substantial way the amount of work which this firm has carried out in the directions mentioned.

Flame Arc Lamps.—THE UNION ELECTRIC CO., LTD., 151, Queen Victoria Street, E.C. List No. 5004 describing "Excello" Arc Lamps is a very attractive production, and one which should be read with considerable interest by central station engineers. The details given of these lamps are very complete; in fact the publication is at the moment the alpha and omega on the subject. After a quantity of preliminary descriptive data, price lists of the present standard patterns are given in the pamphlet.

Printing Installations.—J. H. HOLMES & Co., Portland Road, Newcastle-on-Tyne. The Holmes-Clatworthy system for driving printing machinery is now too well known to need any description from us. It has found its way into the principal newspaper offices in this country, and is being very rapidly adopted in large printing works. Messrs. Holmes have just sent us their latest list (No. 104), which contains the names of a number of newspaper and general printing offices and paper mills, in which they have installed plant for lighting and power. It is interesting to note that ten years ago the company purchased the patents covering the well-known Lundell motors, for the manufacture of which they considerably extended their works. During the last few years they have put down 2462 dynamos and motors in 293 newspaper and printing offices and paper mills, these representing an aggregate of upwards of 21,330h.p. Singularly enough the contracts ranged from installations of 1500h.p. to units as low as ¼h.p. The publication contains a number of very interesting photographs of the various applications of Lundell motors to printing machinery. An item of interest amongst these is a Hoe three-reel printing machine, printing "The Times," and driven by motors on the Holmes-Clatworthy system.

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A Great Revolution

is sweeping over industry, commerce, and domestic life; it has crept forward all unconsciously through the outposts of the past, out-manœuvred prejudice, and overrun precedent, until to-day it is a real living power for good among the great civilized aggregations of men.

Twenty-five years ago the gas interest in this country was panic-stricken at the predicted rise of electric lighting, and became genuinely afraid its days were numbered. Between then and now electricity supply has slowly but surely won over ground, outlived calumny, and come out on top by sheer weight of merit alone. Statistics give but an imperfect notion of its development. But little observation is needed to prove its stability and evidence its undoubted popularity. Quite apart from the electric lamp in street and window, the electric tram and car in country and town, and the electric motor in mine and workshop, electricity now pervades every phase of our existence.

The electrical idea is held in common by all, but has yet to find expression and take practical shape. For long it was confined to that limited circle, encompassed by the bounds of professional research and knowledge; but it has broken loose among the multitude, and till now has lacked the means to direct and influence the many who unwittingly hold it.

It is to supply this omission, and to foster and strengthen current electrical opinions, that Popular Electricity makes its bow to the public with the present issue.

Consumers of electrical energy, whether from public or private supply mains, have hitherto had no organ in the press to which they could regularly turn for information, guidance, and advice. Their numbers have now increased to such astounding proportions, and the many hundreds daily added to the list continue to increase so rapidly, that the present moment is propitious for calling attention both to this crying need and to the medium put forward to meet it.

Popular Electricity will appear regularly as an integral portion of The Electrical Magazine, and in addition will be sold and distributed as an independent publication. Its aim is to bring the reading public to a wider and better knowledge of electrical affairs, while it will also emphasize the many advantages to be derived from using electrical energy either for lighting, heating, cooking, or power purposes.

It is desirable that the great mass of thinking men and women should come to a knowledge of the important bearing which electricity supply has upon the conduct of a nation. The existence in their midst of electricity works delivering cheap light, heat, and power at their very doors, cannot be brought home too strongly, together with the need for adequate support of undertakings which make for the common good. The unqualified patronage of electrical undertakings in foreign countries must be emulated here on every hand, and on no account should prejudice or wilful obstruction influence decisions in favour of modern hygienic necessities. The main policy of POPULAR ELECTRICITY will include a systematic campaign advocating the general employment of electrical apparatus in every phase of domestic and industrial life, and this object will be furthered by the dissemination of instructive information closely related to it.

◆

Brevities.

A single wire can be used for sending both telegraph and telephone messages at the same time. We cannot answer the query of a wag, whether they jostle one another en route. Evidently they are agreeable passengers, and get out separately at the other end, or a number of press agencies would not employ them conjointly over one line.

◆ ◆

Who will deny that London is strongly in need of electrification after this, from an expert on the subject? In its industrial area London has three-and-three-quarters millions population, and only four per thousand are coupled to electric power mains. Twenty-six per thousand use electrical energy for all purposes. Berlin with two-and-a-quarter millions has twenty-two and eighty-two per thousand connected to the respective services, and New York with two-and-a-half millions, thirty-five and seventy-three per thousand. Spark up, London!

◆ ◆

We are advancing rapidly towards making the telephone general in the strictest sense of the term. You can go the round of the theatres in London seated by your fireside, and may hear a political speech in Sheffield, or anywhere else on the line, for that matter. The very latest is trial by telephone, the case being one for negligence and damages. The judge conducted the case from his chamber, and attorneys on both sides argued with him over the phone. A listening world may yet follow future trials at the Old Bailey with telephone receivers glued to its ears.

◆ ◆

The mountain elevator is no longer a figment of the imagination. It is working regularly in Switzerland, and is the delight of avoirdupois Alpine climbers (?). The elevator goes vertically up the mountain side, is in fact a tall steel tower, and at the top an abutting landing gives access to the giddy heights of the peak. As a matter of course it is operated by electricity. Nothing less could be expected.

◆ ◆

It is not the warmth you get from a gas fire that counts. You must reckon on paying for the heat that goes up the chimney or draught pipe. Ask the gas man what rebate he will allow you for all the heat units his fire expends on the brickwork of the chimney. And see you get an answer.

◆ ◆

Our cover is taken from a design published some months ago by the *Technical World* of Chicago. We take this opportunity of tendering our acknowledgments to them for an idea which has proved readily adaptable to the character of this journal.

Signs in the Sky.

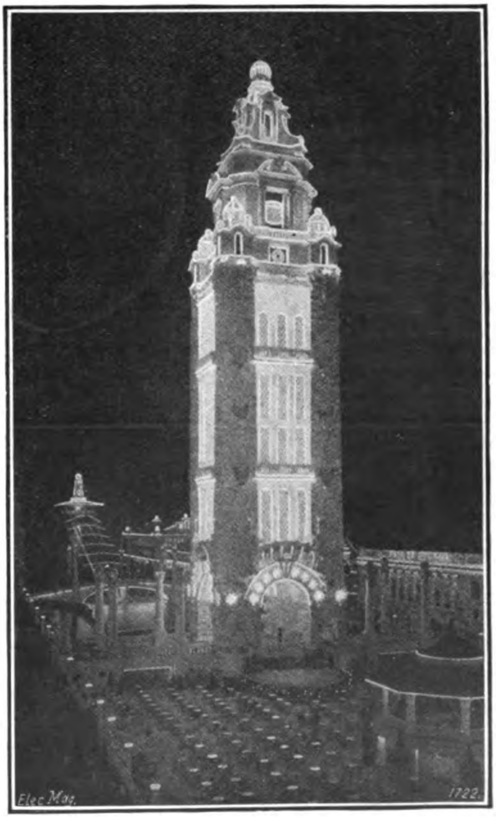
A few of their Portents.

Had you resided within the borders of Greater London during the recent Election your eyes would have been constantly attracted by long or short flashes of light on the clouds or the black vault of heaven. They were Morse signals flicked out by great searchlights and telling the astounding tales of the Government victory and Opposition defeat For a time perhaps you learned to interpret those signs in the sky, but with the close of the electoral contest your interest ceased, as did also the flashes themselves. Some enterprising Yank may endeavour to educate the public mind to think in Morse and get himself rich on advertising revenue for "flashes on Bovril" or some other universal article whose merits should nightly illumine the clouds. That is hardly likely, however, but there still exists the need for education on the value of the electric sign in pushing trade.

You must soon come to realise that the electric sign is the only *good* sign and that gas cannot come up to it, no matter how it is pushed. For instance, look at the picture opposite, which illustrates Dreamland's Tower on Coney Island, New York. It is illuminated with thousands of electric lamps festooned around the building and in close proximity to it. Conceive the same design in gas jets silhouetted against the sky on a breezy night. The tower is a monument to pleasure, but it also is one to the electric glow lamp, which is unrivalled in this field.

Now it is for this very reason you should have an electric sign over your shopdoor. It is absolutely reliable, and on the score of effect it cannot be approached. You can get any effect you want, and in the matter of variety your ingenuity will be taxed to keep pace. There are sign-makers in abundance and to spare. What is wanted is an increase in sign-users on electricity supply mains. There is room for a great many more, as you will find if you see the department responsible for your supply, and get a few figures as to outlay and cost of running. The extra business you will get you must calculate afterwards, but you can be certain there will be an extra.

There must be no half-hearted policy in exploiting the electric sign, however, because unless it is done well, you will just miss getting good results. After a careful review of your business, see that you hit on the right ideas for the sign, and then lose no time in putting it over the door or in the window. A change is of course essential after a time, but a breezy idea will have a long run and still attract attention.



Dreamland's Tower, Coney Island, New York, Lighted by Thousands of Electric Glow Lamps.

Fashion materially affects the electric sign, so that the prevailing notion must be taken into account when settling on your sign. Still you need not be bound hand and foot to things as they are, and are free to launch out as you please. The great point we would impress on you is, decide on the electric sign, get it up, and run it for all it is worth.

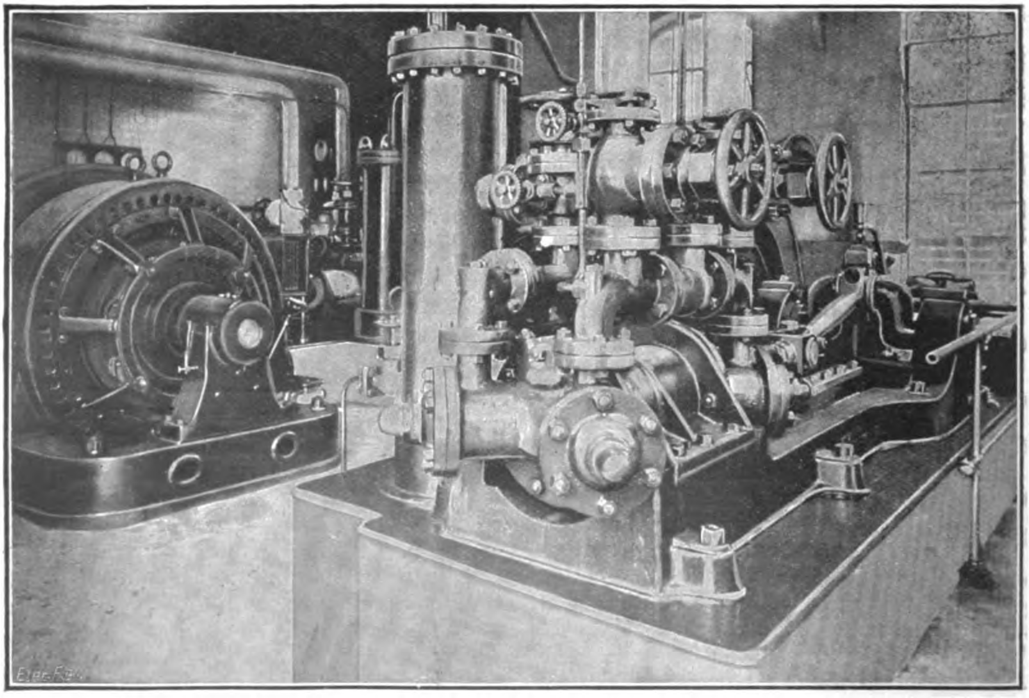
Ice Making by Electric Power.

Advantages over Steam and Gas Power.

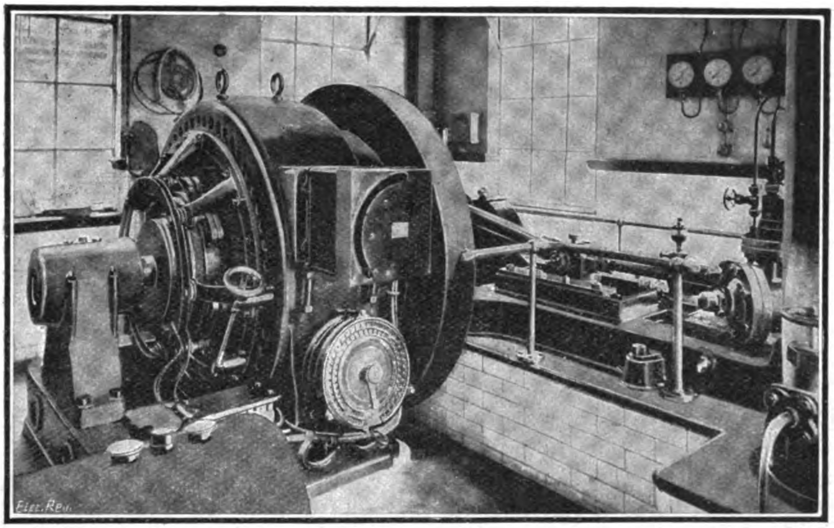
We little realize, when enjoying a plump chicken or hare which we know has come from abroad—by steamer of course—what ingenious devices contribute to keep such comestibles fresh and sweet before they reach the table. Cold storage, once a trade wonder, is now but lightly associated with our food supply and at times is summarily dismissed as of small consequence beside the more ostentatious sections of industry. Refrigeration is now, however, an art. It stands aloof, in specialized isolation, from the swollen ranks of engineering, and claims factories, transport facilities, and trains, all for its own. You must become a "refrigerating engineer" before you qualify for inclusion in the ranks of ice makers.

But we are here chiefly concerned with that function of the freezing process needing power for its performance, the driving of the ammonia compressors. We will not go into details of the latter, as they are always included in the business, and what we shall talk about are more particularly the driving arrangements. Until the advent of electricity these compressors were driven by steam, gas, and oil engines, and belting, gearing, or shafting were generally needed to transmit the power to the compressor shaft. Those of our readers familiar with spur gearing, even with raw hide pinions, will know that the noise, wear and loss are undesirable features of what is at best a bad arrangement. No need to emphasise what must already be apparent. Again, the inconveniences of steam and gas tend to reduce the all-round efficiency of refrigerating machinery which requires all the flexibility in driving it can possibly receive. What is more annoying than to have fires to tend or a heavy flywheel to "lag round" when starting up after a temporary shut down!

Refrigeration has too long been attached to "undesirable" power agents, but now sees



View of 30h.p. Motor on left and Compressor Plant on right. The left-hand Motor is driving a Compressor which can just be seen behind it.



View of Complete Electric Motor and Ammonia Compressor. The Starting Switch and Regulator are on the Motor Frame.

the folly of its ways. The speedy, compact, and handy electro-motor is its real labour partner and it only needs time to make them absolutely inseparable. A healthy specimen of an electrically operated refrigerating plant is that of Messrs. Aplin & Barrett, Ltd. (of Yeovil—where St. Ivel cheese and Golden Meadow butter come from), at their Battersea depôt, where two large ammonia compressors and accessory plant are operated solely by electro-motors. Belts, gearing, chains, and pinions are done away, for each motor is coupled solid to its compressor shaft, and directly drives it. Our illustrations clearly indicate the compact nature of the installation, and show how neat a thing the motor is compared with the usual methods of driving. Each motor develops 30b.h.p., and operates normally at 100 revolutions per minute, but a most valuable feature, and one which should commend itself to users of steam and gas driven plants, is the variation of this speed, provided for in the motor down to 66 revolutions per minute. The simple turning of a regulator switch effects this desirable result, and further, no internal or external gearing is employed.

To the users of refrigerating plant this speed reduction spells economy. It means that when the demand is lighter, as in the winter months, a lower speed can be put on the compressors, and much less power is consumed because the motor takes energy in proportion to its speed. The temperature meantime is steadily maintained, and the machines are shut down for shorter periods than if steam or gas engines were used.

Two cables laid in steel tubing convey the energy to and from the machine, and there are no accessories excepting only the starting and regulating switches, which are really integral with the motor case as they are fixed securely to it. Boilers, steam pipes, coal, ashes, water tanks, and coupling pipes are quite "impossible" where electricity can be obtained cheaply.

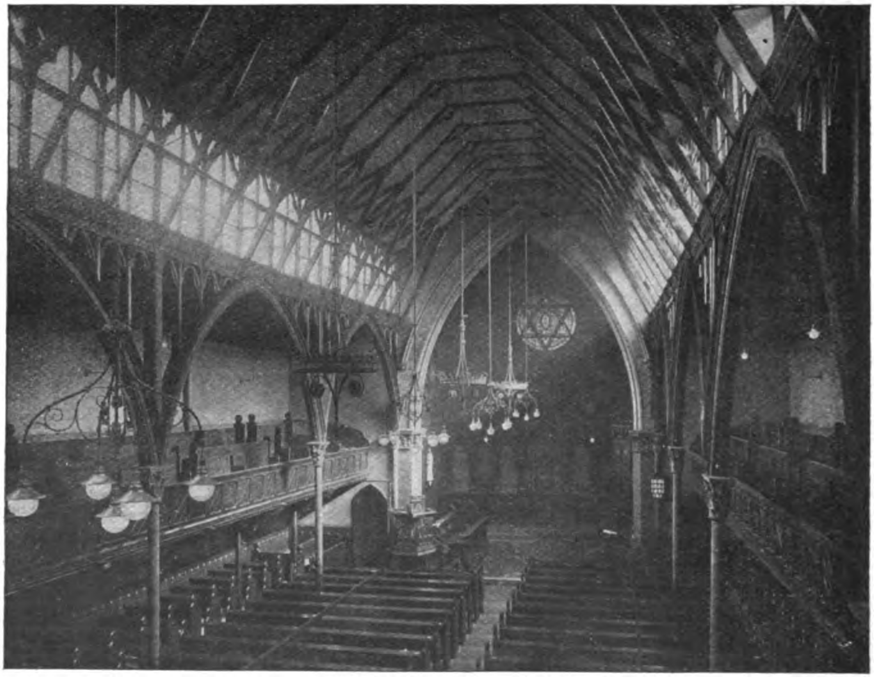
This brings us to the question of the energy supply, and it is this in itself which gives electric power its chief charm. In Battersea, where this plant is working, electrical energy is "on tap." The Borough Council furnish it from street mains, and will bring it to the door if the demand and the customer are all right. You have simply then to knock a hole in the cellar wall to let in the cable, and there your external trouble ends.

The old dream of a cheap supply of power is fully realized in electricity, and it only needs the co-operation of power users to make the efforts of the suppliers, no matter who or where they are, a huge success.

The plant has been erected to the designs and specifications of Mr. Philip Dawe, A.M.Inst.C.E., by the Haslam Foundry and Engineering Co., the motors being built by Messrs. Newton Bros. of Derby.

To Lighten our Churches.

WE wonder, in these progressive times, how our forefathers paid their religious vows in the dim candle light of aisle and cloister, while our songs and prayers need nothing short of the full blaze of electric lights artistically hung from pillar and arch. The grim effulgence of gas is now regarded, at least in the domain of progressive religious thought, as unfitting, nay, almost sacrilegious, to illumine the sacred fanes of our land. The sacerdotal glories of Catholicism with the humble unadorned devotions of Nonconformity must now alike be graced with the presence of the simple glow lamp. The "effect" sought by the one, and the *fin-de-siècle* look dear to the heart of the other, are equally well supplied in the expedient electric lamp. St. Paul's was endowed with a new charm when gas ceased to pollute its atmosphere and cast its taint over the statues of the nation s heroes. Mighty as are its vaulted spaces, they are cleaner for the breath of thronging worshippers, undefiled by fuming mantle and flaring gas jet. Pagan gods and even the God of Israel might have loved the smoke of the sacrifice, but what Christian can wish to suggest in the flames of batswing burners, or the fumes of Welsbachs, the ancient practices of his forefathers?

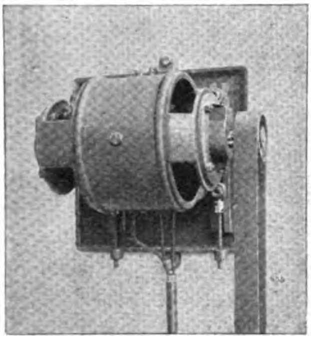


St. Paul's Church, Hulme, lighted through with B.T.H. Meridian Electric Lamps.

We are enlightened in these times. Our light shall not remain under the bushel of old, but be shed on all who seek the rest and solace of our sacred places. The growth of electric lighting in churches has yet to be reduced to statistics, but certain it is that whenever the installation can be made, nothing is allowed to hinder its completion. "The expenses this evening are for the electric light" is announced from the pulpit, and the hearty response shows the tendency of public opinion towards the better things of this life.

The Small Motor & a few of its Applications.

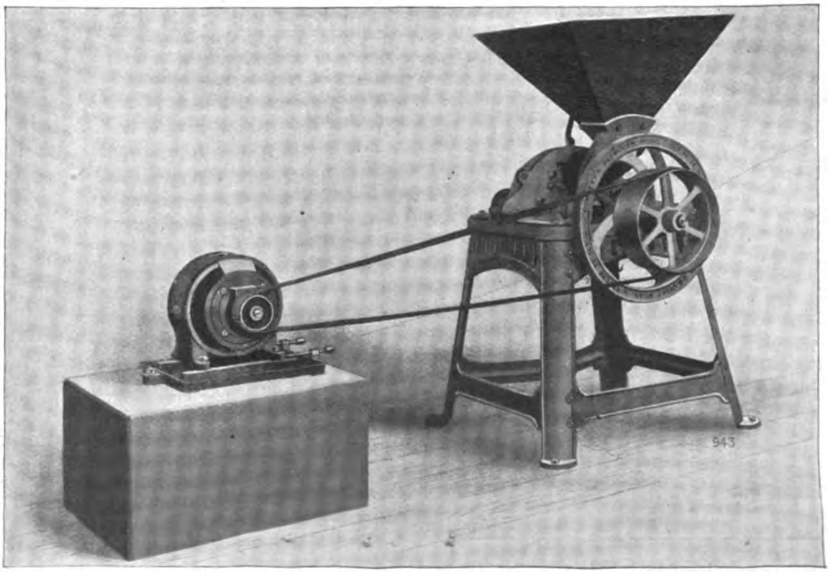
A Word on "Crank" Power.



A SIMPLE MOTOR BOLTED TO THE WALL—IMAGINE A GAS ENGINE JUST THERE TOO.

NEVER before in the history of civilisation were there such opportunities for cheap and readily applied power as now prevail in our midst. The present time is an El Dorado of electric power, and we are most of us unconscious of it. Popular ideas of power machines are still almost hopelessly entangled with flywheels, cranks, pistons, cylinders, and pipes. The crank, for instance, has been so long with us that we have become cranks and crankish. It is hard to dissociate the shaft from the crank and the crank from the mind, and we still have among us small and wasteful examples of crank power. Steam, gas, and oil engines in tiny sizes are bad specimens of crank power, and they inhabit the dark corners of industry, beating out a pulsating and throbbing existence, unworthy of the cause in which they labour.

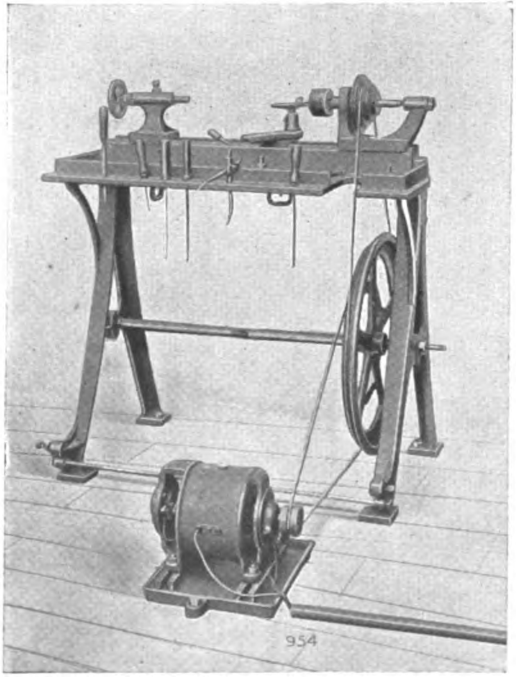
The day has now dawned for a change of thought on power methods. The needless paraphernalia of power must be banished not only from the mind but from the land, and a single simple idea must take their place. That idea is practically embodied in the compass of the neat compact electro-motor. The word motor flows so glibly from the tongue that it serves well to describe the subject of these few lines. Motor—that is electro-motor — means just revolution — turning—that and nothing else. Not push and pull, beat and throb, wheeze and groan, oil and mess, smoke and smell, loss and worry. All these latter cluster round the word engine, whether gas, steam, or oil. You can't deny this because perhaps you experience it. For years maybe you have tolerated it the while you read of something to do away with it. Your cellar or attic



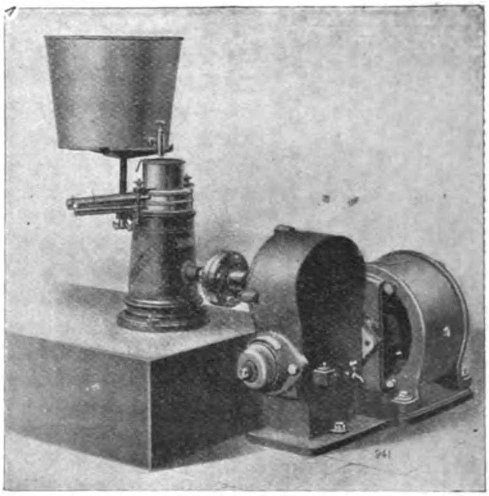
Motor Driven Turnip Slicer.

probably contains a "thing" to which all the above applies and a lot more. No doubt you emphasise it, forcibly and audibly, both in and out of season. Well, really there is no need for expletives over an explosive engine. That engine should cease explosion by expulsion! Why, you say? Because the tale of the electro-motor is so simply told and it so easily does all you want it to do.

As we have said, the term motor is just rotary motion put into the vernacular, and the actual thing is nothing more or less than rotary motion—revolutions per minute inside a case. It's a lot too quick to see, but it's there, and you can prove it. Look at the pictures on this and the previous page. The first is the practical exemplification of one word—motor. The second is a similar motor belted to a turnip slicer, and you must admit it looks business-like. Didn't know turnips could be cut by electricity! Oh, yes, quite one of the baby things it can do, although it's not in its infancy now. You thought it was? You must stand corrected on that point, anyway. Number three is a wee Macgregor—motor we mean—in position for turning a lathe. It does not look as if it could do it, but it can. Ask somebody in your town to show you his electric lathe, and you will see for yourself. If it's a big lathe you've got, it makes no difference. The motor can be fitted into the headstock, and the thing looks as if it had no means of driving it. And of course you couldn't fit a steam or gas engine into a lathe headstock. Not going to try? No, certainly not.



Small Lathe driven by Electro-Motor.



Cream Separating by Electric Power.

The last specimen will come a little nearer home perhaps. It's a cream separator driven by a small motor, and it, too, looks like business. You only turn a small switch and supply the milk, when the motor will do the rest. Want oiling, you say? What, the cream? No. Oh! the motor?—about once every six months. It sees to its own oil supply for its bearings, without troubling.

Now what we have said will give you an inkling of the power agents at your very door. If you only say the word, anything in reason will be done for you by the local electricity works to usurp the sway of steam, oil, and gas over your business life. An electric motor must be seen to be believed in. It is not much to look at, and it won't hit you in the chest with a crank pin, but it is a "mighty" good thing, and will serve you well. Cheap? That goes without saying, or it would not be alive now. But you can get all the figures from the man who supplies your electricity, because he knows his price and will quote you what his delighted customers are saying on that little motor which we have just been talking about. All pictures are of Crompton Motors.

POPULAR ELECTRICITY.

A JOURNAL OF ELECTRICITY SUPPLY AND GENERAL ELECTRICAL INFORMATION.

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THE MOST REMARKABLE, most useful, and most interesting periodical to-day dealing with electrical matters is The ELECTRICAL MAGAZINE. Each issue contains from 100 to 200 pages of valuable matter splendidly illustrated. It is a journal which every man interested in Electricity and its applications should take. A single copy will be sent by the publishers for 9d. in stamps, or it can be purchased for 6d. on the bookstalls, or ordered through your newsagent. Address: 4, Southampton Row, London, W.C.

Sparklets.

POPULAR ELECTRICITY is not a shocking paper. You may be electrified with its contents, but unless you are desperately electro-sensitive you will recover in time to read the next issue. It will stagger you again.

* *

Enthusiastic readers who use electric light and motors are requested to send in their suggestions to our Grand Inquisitor, who is daily engaged in weaving torture schemes for gas shareholders and users of gas burners. He has also a hot corner for the reporter who attributes fires to the "fusing of electric wires."

* *

Governor Higgins, of New York State, recently said that "in Great Britain the gas charges in municipal plants averaged 2s. 8d. per 1000, and in a number of cities was as low as 2s. In the United States the average charge was 5s. per 1000." This accounts for the popularity of electricity supply, or as Americans term it the "electric service."

* *

Electrical exhibitions are now open daily in every city, town, or village boasting electricity supply. This may surprise you, but you have only to walk down the main street at night to prove it. Are not the tastefully lighted windows an exhibition of arc and glow lamps which would be hard to beat? You will find a lot of things no farther than your elbow, waiting only the finding.

* *

Radium is everywhere, so experts tell us, and we listen always to experts, sometimes without conviction. Our readers will doubtless agree with the theory held by Prof. F. Soddy of Glasgow University that gold is gradually disintegrated into other materials. They will have experienced this startling phenomenon doubtless on more than one occasion.

* *

When lighting your cigar at home be satisfied with nothing short of the electric lighter. On your walks abroad a humble vesta must answer, though you can light up by electric if you care to carry a battery in your pocket. We don't suppose you will, but if you have a motor car your ignition batteries will supply energy to start the fragrant weed, even in the highest wind or when doing the legal limit—and over.

* *

Know the *gas* arc, eh?
Use it regularly and always abuse it.
Should put up the real thing; the electric.
What's the good?

Three thousand gas arcs were stopped lying in Massachusetts State last year by same number of electrics. *That's* the good!

The World's Water Powers.

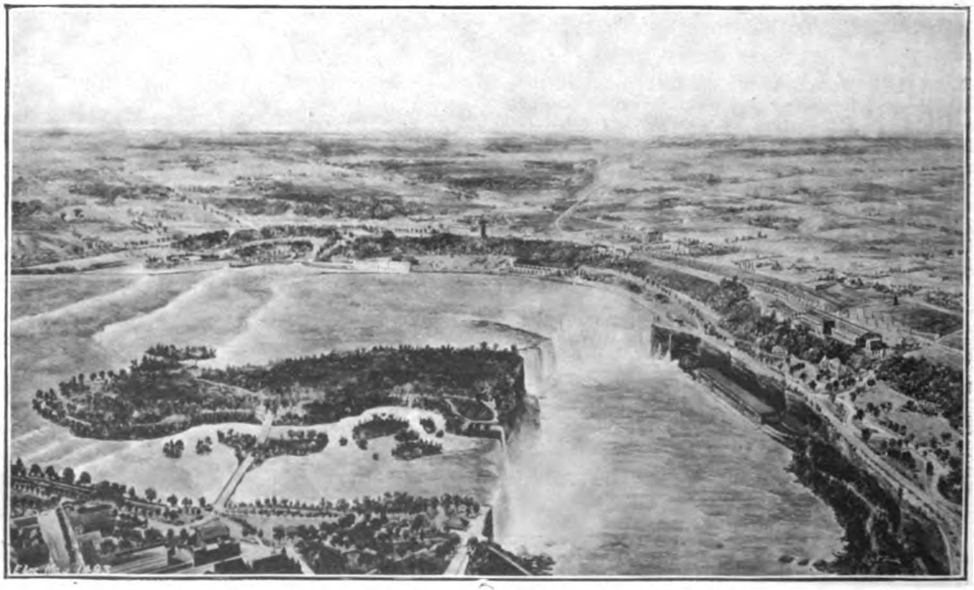
THE conquest of the great waterfalls of the world and their conversion into electrical energy is one of the mightiest of engineering achievements. We can find no parallel for it in history, nor is there the least jot or tittle of evidence to show that our ancestors availed themselves in this manner of nature's powers. To turn the forces of falling water to good account and then convert them into a readily transmissible form of energy, is a triumph of man over material, and constitutes an advance in science which is unprecedented.

At this moment we have ceased to wonder at feats once compelling amazement, and, in this country at any rate, settled ourselves to the work of doing similar deeds, only by the aid of steam.

In America and on the European continent, in India, Africa, Australia, and New Zealand, however, are almost unlimited, and at present undeveloped water powers which may yet be made to give up their energies to man. In the first two named countries great works are in operation and form the centres of flourishing manufacturing districts. Niagara, the St. Lawrence, and other rivers in America and Canada can boast of hydro-electric plants, as they are called, and year by year, almost month by month, the number is being added to

The pioneer work of these great schemes often involves journeys over mountain chains, up fertile valleys, and through narrow defiles. Much as the waterworks engineer seeking a gathering ground for a projected reservoir surveys the prospective neighbourhood, so also the hydro-electric pioneer leaves no stone unturned, no likely spot unviewed, in his labours of finding water for the plant. Dams, reservoirs, pipe lines and flumes, each and all figure in the work of bringing water to the wheels in the power house. Mountains yield their hurrying streams to the intake at the head works and lakes are drained to fill reservoirs at some level below.

The glacier waters of snow-capped peaks are made the sole source of power in some American stations, and the very complete



Electric Power Houses around Niagara Falls, where little short of One Million Horse-power, or One-fifth that of the Falls, will soon be in operation.

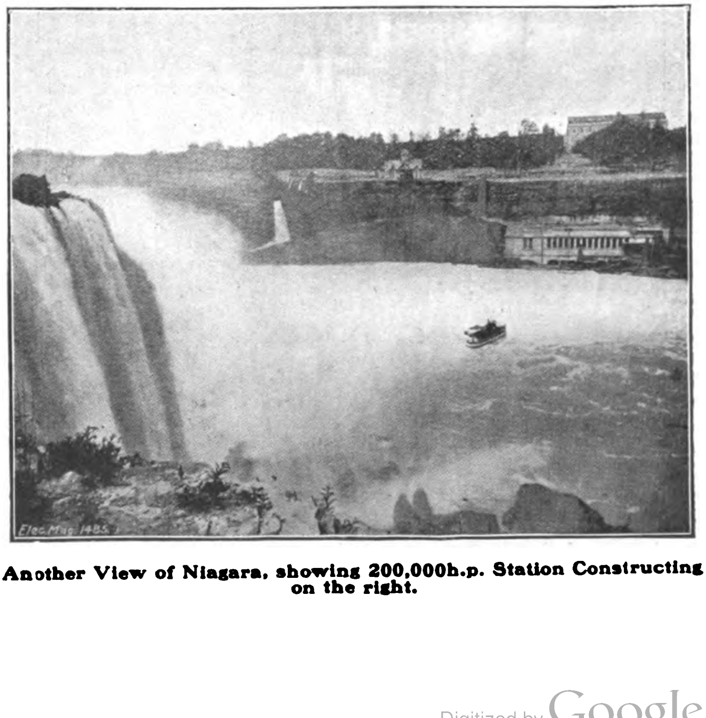
Mont Blanc and its Neighbouring Heights, whose Snow-clad Peaks Furnish Electric Power in Switzerland and France.

impounding arrangements afford absolute immunity from interruption from shortage. Mount Rainier, U.S.A., some groups in the Rockies, and the Alps, are the sole sources of energy to thriving industries, built up as a consequence of the cheap power, quickly available after the opening of the plant.

Here in Great Britain we have only coal to depend on, and at present are relying chiefly upon it for industrial and domestic purposes. Our electricity (except in a few isolated cases) is also generated by steam stations, using coal under their boilers, so that water power is at a discount. Our enormous coast line, however, encourages the belief that the rise of the tide in the many narrow inlets may be taken advantage of to generate electric power. Suitable impounding works could entrap the water as it rose with the tide, and at the fall would represent a great amount of concentrated energy which, in being allowed to flow out and fall to the low-tide level, would drive generators and produce electricity. This has, however, to be our last expedient when coal is gone or too deep to bring profitably to the surface.

To the man in the street, not perhaps so much in this country as abroad, these uses of water power mean a great deal. They will bring within the reach of all the benefits derivable from electric light and power, and at rates which, though now high, will at first compete with steam plants and ultimately subordinate them. Both home and commercial life will share the blessings, for they are such, which electricity alone can confer upon a community. The movement is well established now to distribute cheap electric power, and nothing can stop its going forward, as it has been begun under exceptionally favourable circumstances.

Our object is to make Electricity Popular and POPULAR ELECTRICITY a household word.



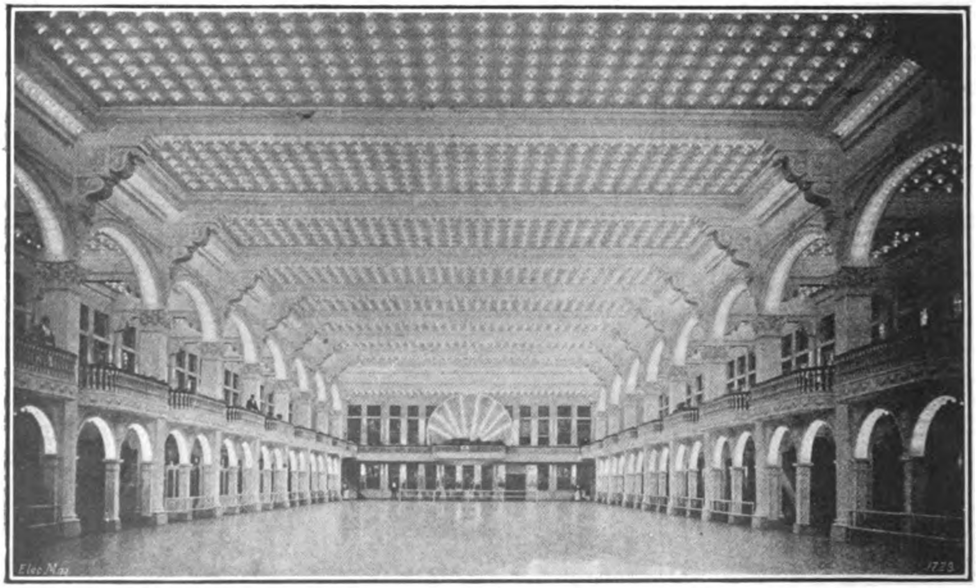
Another View of Niagara, showing 200,000h.p. Station Constructing on the right.

Thoughts on Inverted Burners.

The gas interest has of late inverted its policy. It is burning upside down. This is but the natural outcome of events, and nothing else could be expected, since gas has always been very much in the air. The real meaning of the word inverted has, however, a peculiar significance. Americans speak of anything which fails to find favour, or which is comparatively speaking a failure, as being "turned down;" hence, of course, the inverted or turned-down burner. A complete revolution in gas lighting, it is announced, is heralded in this the latest gas burner, but that is not strictly correct. It is only half a revolution, as the inverted burner still hangs at a point diametrically opposite that which it normally occupied. When that gyration about a fixed point is completed, then only can it be truly said that a revolution has been accomplished.

But joking apart, are these inversions (or perversions) such rivals of electric lighting as they are claimed to be? Can they fill all the vacancies in the electric lighting field which their existence is supposed to create? This ball-room, for instance, illustrated below. Look at its myriad glow lamps studded closely in ceiling, arch, pillar, and cornice. There are 500 in each panel in the roof, or a total of about 2000 in the ceiling alone. We have no details of the others, but they are all embedded in the plaster, and in appearance are an integral part of it. The effect is glorious in the extreme, as you may judge from the picture.

Inverted gas burners be blowed! do we hear you say? Certainly, we agree it would be quite impossible, unless, of course, the management desired branding as incendiaries embued with a desire to incinerate their beautiful hall. The most natural question to ask is, if the inverted gas burner is unworthy a place in this palace of delights, can it with equal justice be received into the sanctity of your home, and become a menace to the health and lives of those you hold dear? There are no gas inverted burners in the London Coliseum—how could there be?—and is your home or shop so very much worse? Figure it out; the exercise will bring wisdom.



A Remarkable Installation of Electric Glow Lamps—The Ball-Room, Coney Island, New York.
Each lamp is distinctly brilliant, giving a pleasing and effective distribution. The building would be reduced to a cinder if inverted gas burners were tried to give the same effect.

Telephone Cross Talks.

* *

When small telephone exchanges get burnt out in America the service is not discontinued. Not at all. An operator perches himself on the leading-in pole and transacts business by "trunking" subscribers from the bare wires.

* *

Dr. Alex. Graham Bell, who has done more for the telephone than any man, has presented the Volta Bureau, Washington, with £15,000 on behalf of the work of research among the deaf and dumb. The gift is a memorial to his father, Prof. Alex. Melville Bell.

* *

Whatever else you may like to do to the telephone, always keep your temper, or you will rue it. A domestic servant was recently arrested for abusing the operators who, to her thinking, were not quick enough in getting her connected.

* *

The Ubiquitous Telephone.

The telephone has long since ceased to be a laboratory toy, it is an indispensable adjunct of our daily life. We simply couldn't do without it. It is true a lot of us have got it and would like to do away with it, but the need of it would be at once felt were it removed. We no longer wonder at the marvels of the telephone because it is now too common an object in our affairs. To appreciate the telephone you want to step into an exchange and get the manager to show you round. After you have inspected the thousands of terminals, wires, coils, indicators and other paraphernalia of a great electrical talking system, and when you have seen the rows of operators busily engaged at their task of "putting through" importunate subscribers, you will perhaps when next making a call be less impatient and snappy. You will have come to realise that the process of telephoning is not a mechanical function but requires human skill and experience.

But the telephone is now everywhere. During the recent great electoral campaign its simple service has enabled you to receive results a few minutes after their announcement many hundreds of miles away. Wherever you are, if you want to send a message or get in touch with persons far distant, your thoughts naturally turn to the telephone. Our American cousins have raised telephony to the level of an art. They seem to vie with each other in putting it to new uses, and we hear that the latest invasion is that of the barber's chair, from which during the process of a shave or a hair-cut one can keep up one's business relations without unnecessary loss of time ! This really beats the hotel bedroom telephone, which has of late years become an intolerable nuisance to visitors lacking appreciation of commercial zeal.

Fireman Using Street Telephone.
Illustration by courtesy of General Electric Co.

Booming the Electric Tram.

The cry now raised in this country is all for the motor omnibus and no more electric trams. The excellent public service given by the latter is of little consequence. They are obsolete, clumsy, restricted and noisy, say the motor 'busites, and the sooner they are done away the better for public nerves and pockets. But where would the motor 'bus be without good roads? In the gutter, we hear someone remark. Exactly, just there. In this country, fortunately for petrol-driven vehicles, we have excellent roads, but "on the other side" such things are mainly conspicuous by their absence. Even sidewalks are merged into the apologies for roads, and steering home by the curb at night is impossible in a lot of places because that blessed guiding line "ain't there."

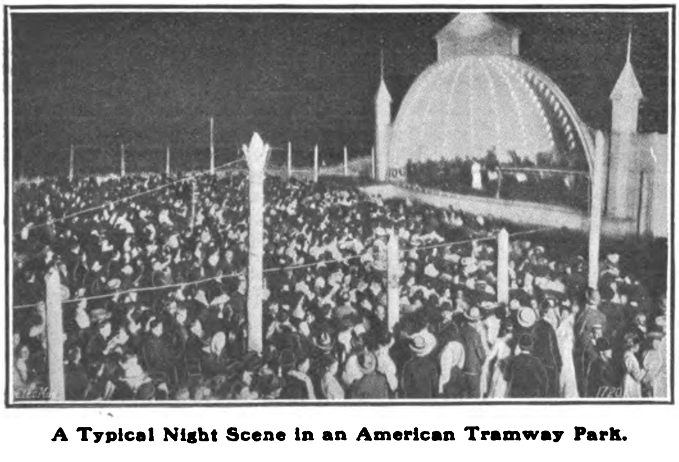
But what is lacking in roads is made up in electric tramways and railways. There's no humbug about American "street cars." Public convenience is absolutely worshipped in the desire to make those trams pay. At least that's what the traffic manager will tell you. As a matter of fact the paying comes first, but the people do come in for a lot of good things which they wouldn't have if those trams weren't there.

The traffic manager weighs up the case in this way: the trams are to ride on and folks will ride if there's something to ride for. Why can't I fix up that something somewhere, run my lines to it, and then persuade everybody it's worth coming out to see? And he does it.

To bring Passengers to the Trams.

On the outskirts of most large American towns blessed with extensive electric tramways, the management buys or rents parks, fields, groves, rivers, or whatever will attract and make a pleasant afternoon's outing. The lines are run to the gates and five cents lands you there from the "city," perhaps five or six miles away. Any suspicion of dullness is banished by shows, operatic entertainments, bowling alleys, skating rinks, and what not, while the quiet-seeker can wander among trees and flowers, grassy banks and wooded slopes without let or hindrance.

The "tramway park," to use the local expression, is now an institution of American and Canadian life, and needless to say it would not continue to exist if it did not pay. Both the public and the tramways derive pleasure and benefit from the idea, and there seems to be no end to the novelty of the attractions provided. Here's a tip for British electric tramway managers. It merely needs a little enterprise to give us tramway parks. Our beautiful country can be reached by the electric tram, but it does not always attract the multitude.



A Typical Night Scene in an American Tramway Park.

Things you ought to Have.

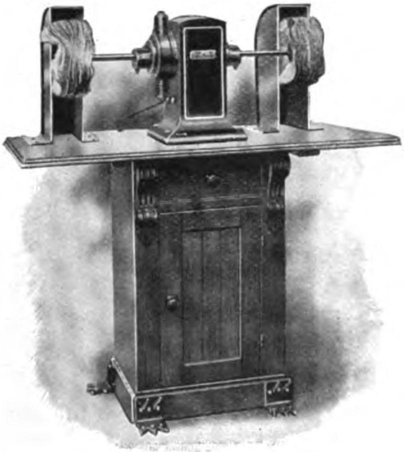
You may always turn to this page for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

The Electric Boot Polisher.

The shoeblack's art is no longer worthy the name, for boots can now be polished by electric power. The picture below depicts a small motor with a pair of buffing discs suitable for giving a high polish to boots. The device is self-contained and very light, and its value for hotels and large establishments is incalculable. All particulars are available from Electromotors, Ltd., Openshaw, Manchester, who will be delighted to forward same, or to show the device in operation.

Remember Ventilation.

Our fathers and forefathers only ventilated their opinions. We must do likewise, but in addition are almost legally compelled to ventilate our rooms and public meeting places. The electric fan is the best air-shifter known, and should be got to work where custom depends on a clean atmosphere, or where employees' health is at stake. Adjoining is a view of a neat little fan which will move more air for less current than many of its size. If you are interested write to the same firm which exploits the boot-polisher mentioned on this page.

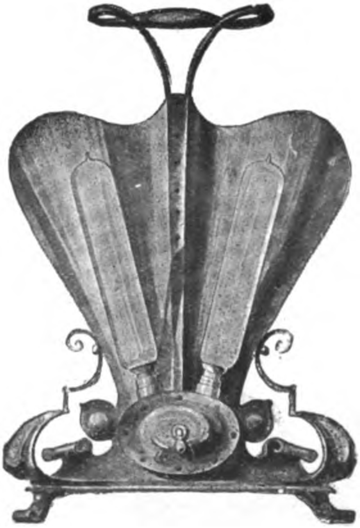


Electric Boot-Polisher.

Bedroom Radiators.

It is not edifying to go to bed and get up in these cold days without fire. But what trouble fires cause! An electric radiator is the thing you want. You only need move the switch, and are at once in the path of the warming rays. If you are used to refinements you can put the switch by your bedside and light up a little before getting out in the morning. The General Electric Co., Ltd., Queen Victoria Street, E.C., will tell you all about this if you drop them a P.C. for their heating catalogue. You get it next mail.

An Electric Air-Shifter.



A Bedroom Comforter for the Cold Mornings and Evenings. A Touch on the Switch at once lights the large Glow Lamps.

Electrical Impulses.

"They call it electric light," Pat confided to his Lordship, "but it do beat me how they make the hairpin burn in the bottle."

◆ ◆

The electrical engineer of —— was asked by his wife to bring home the latest pattern sheet, but he has an abnormally bad memory and astonished the drapers' lady clerk by asking over the telephone for the latest style in sheets.

◆ ◆

Lawyer to bibulous wireman: "Now look here, before I take your case I want to know if you're guilty."

B.W. "Am I guilty? D'yer spose I'd be fool enough to hire the most expensive lawyer in town if I wuz innercent?"

◆ ◆

The following is a short story of a telegraph operator in domestic difficulties. Bill had a bill board. Bill also had a board bill. The board bill bored Bill, so that Bill sold the bill board to pay his board bill. So, after Bill sold his bill board to pay his board bill, the board bill no longer bored Bill.

◆ ◆

"Jones," said the electrical engineer to the head clerk sternly, "I caught you kissing the typist when I came back from lunch this afternoon. What explanation have you to make, Sir?"

"Why," replied Jones without moving a muscle, "you told me to attend to all your duties in your absence."

◆ ◆

Two Irish telephone linesmen were returning from a day's pole-setting, and in crossing a bog one of them fell into a mud-hole.

His mate ran to a near-by farmhouse and asked for a spade.

"What do you want it for?" asked the farmer.

"Shure Mike is stuck in the bog, and I want to dig him out."

"How far in is he sunk?"

"Oh, up to his ankles."

"Begorra, then he can asily walk out," replied the farmer.

"Begorra, but he can't," retorted Mike; "he's in the wrong end up."

Shift Engineer at fashionable tailor's: "Do you let out your dress suits?"

F.T. (without so much as a smile): "Only when they're too small, Sir."

◆ ◆

On the Electric Railway. "Pat," said plodding Pete, "we're getting left again." "What's the matter?" asked Pete. "Why, don't you see, if dese railroads gives rebates to de people dat pays, us fellers dat rides free oughter have a bonus."

◆ ◆

Our poet thinks the following might well be applied to the motor 'bus:—

A buzz—a whirr,
A cloud of dust,
A wild blood-curdling yell,
A ghastly object flashing by
Then silence—and a smell.

It is only fair to state that since producing this our poet has been knocked down by an electric tramcar.

◆ ◆

An absent-minded electrical professor was recently observed walking down the street with one foot in the gutter and the other on the pavement. A pupil accosted him, and wishing him good-morning enquired after his health.

"I was very well, I thought," answered the professor, "but now I don't know what's the matter, for the last ten minutes I've been limping."

◆ ◆

A Welsh stoker at the C—— Electricity Works was laid up and called in one of his countrymen who was a physician. Detecting no signs of improvement he enquired for an English doctor, who, on his arrival, felt his pulse and examined his tongue.

"Did your other doctor take your temperature?" he enquired.

"I don't know, boss," replied the stoker, "I don't miss anything but my watch so far."

◆ ◆

A bankrupt wireman commenced business a few weeks ago in B—— as a fly proprietor, and naturally put up an electric sign. He represented himself holding a mule by the bridle, and was mightily pleased with his enterprise when the sign shone out at night.

He inquired of a friend, "Is it not a good likeness of me?"

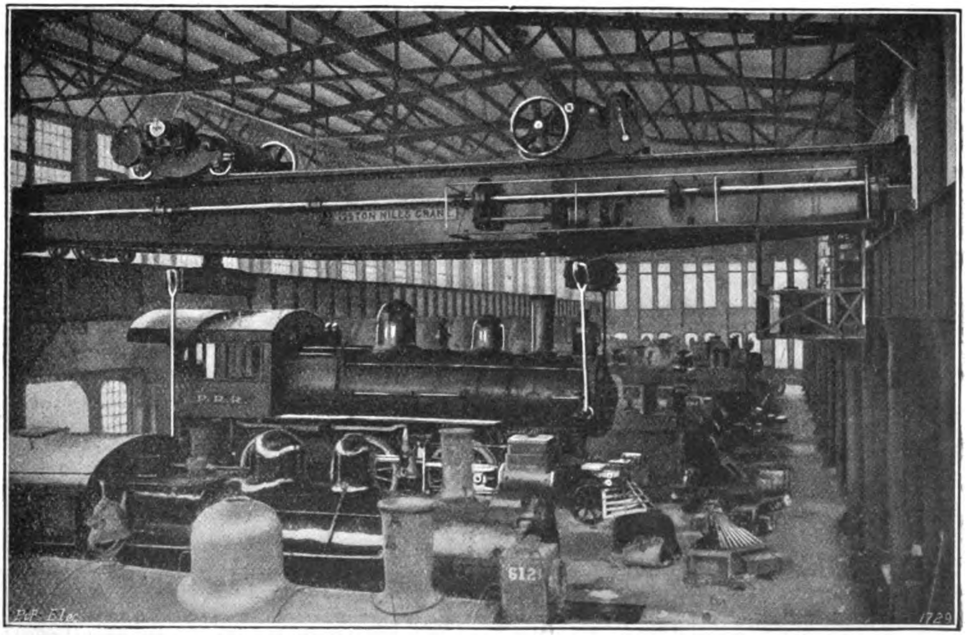
"Yes," was the answer, "it's a perfect picture of you, but who is the fellow holding the bridle?"

PROFUSELY ILLUSTRATED. ONE PENNY.

POPULAR ELECTRICITY

Electric Crane Wonders.

Could you but watch a mammoth electric crane swiftly and smoothly responding to the will of the man controlling it, you would, on reflection, count it a wonder among mechanisms. A brief glance does not give you pause to consider what is the force moving those great masses, for you may regard an electric crane as quite an ordinary sight and in no way typical of a nation's development. If you stood beside the man in the cage your wonder would change to amazement if you pondered over the man's strength and thought of the huge weights which the slightest movement of his arm caused to rise and swing hither or thither to their appointed place. The locomotive hung from the crane girders in the illustration below gives some idea of what can be done with applied electric power in the greater processes of industry. The cage on the right contains all the controlling apparatus for raising and transporting the "Atlantic Flier" wherever it may be desirable, and all is so evenly accomplished that to the uninitiated it seems next door to miraculous. The handy motor is bolted to crane girder or crab carriage and in each case does its part of the work while the man in the cage need scarcely turn a hair. That 100 tons can be swung 100ft. or ¼in.



125-Ton Electric Crane, lifting 100-ton locomotive complete. Two separate travelling crabs are used to give the lift at both ends of the locomotive.

At the London Coliseum.

THE modern theatre without electric light and power would be impossible. No other word will describe that which, however, needs no description. The stage manager of to-day is not likely to go back on electricity. It is too good a friend to him. Consider for a moment the London Coliseum. Could the bold conception of those three whirling stages have become real, and mystified crowded houses, if electric power in the handy motor had not offered its services and made the thing possible? No need to wait answer to such a question. The man bold enough to think of revolving a 75ft. table at a speed equal to 25 miles per hour by a steam or gas engine has never yet dared to put his mental audacity to the test of experience.

There is no getting away from the point, and the reader will appreciate it, that London would be minus its great palaces of delight if electric lighting and power ceased to be. We have not taken the Coliseum as our example this month because we want to tell our readers there are so many lamps there, and so many motors which, if lighted or worked together, would furnish this illumination or that power. We will tickle their ears with statistics served with popular sauce in due course. We want particularly to point to this modern playhouse as a monument to the skill of the electric light and power engineer. It is a complete triumph for the electrical art, and as such deserves to be known through the length and breadth of the land.

The very daily programme itself spells out electricity in every "turn," and the triple show within nine hours compels thought on the "electric" nature of the management. During the performance the tedium of waiting between "turns" is relieved, for each change is preparing behind the scenes and during temporary darkness takes the place of its

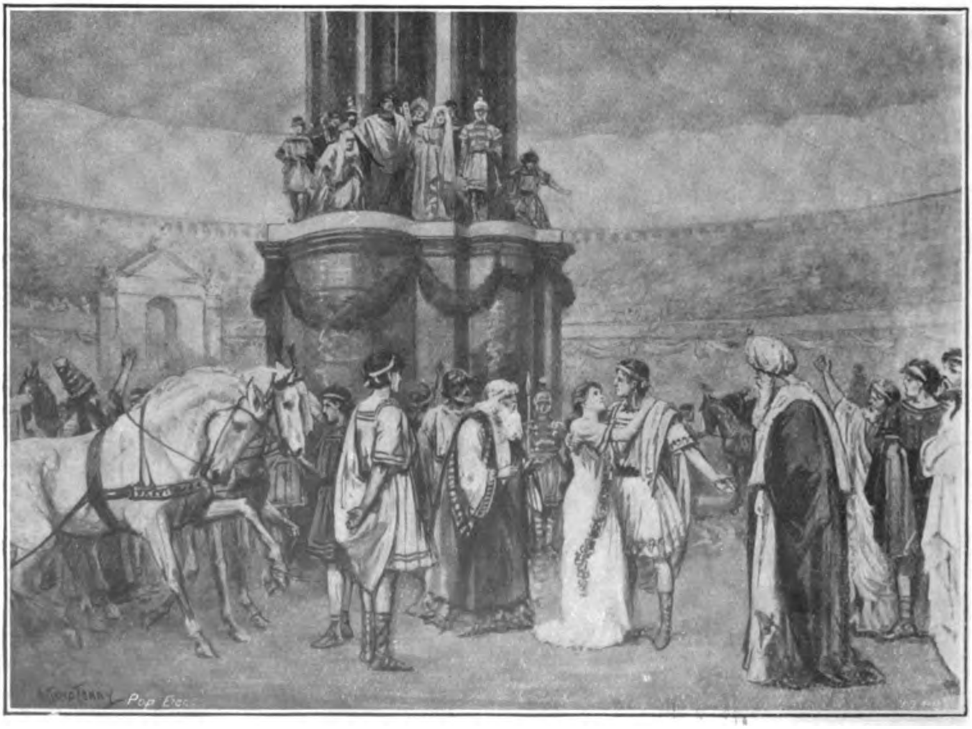
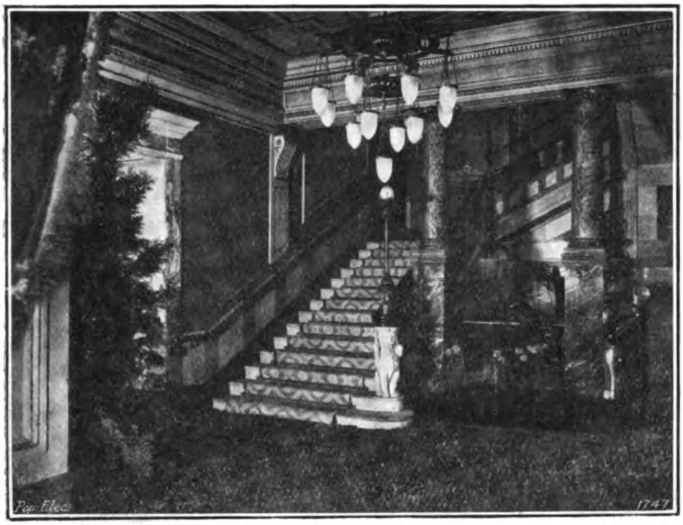


Photo [Campbell Gray.

Scene on the Coliseum Revolving Stage after the Finish of the great Chariot Race, in which the stage revolves at high speed.

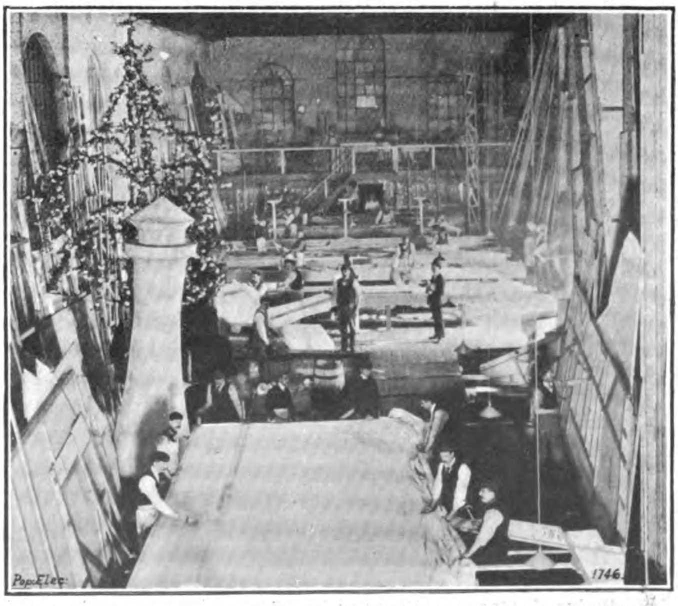


The Grand Staircase and Foyer of the London Coliseum, brilliantly lighted at night by tastefully arranged Electric Lamps.

of the proscenium. Here he commands a full view of the stage, and receives signals from below which guide his movements. He adjusts his controller beforehand, and the pressure of his thumb on a small switch closes the main circuit and applies current to the motors for the speed desired and already predetermined. Although the lighting of the spacious halls, galleries, ceiling, and stage of the London Coliseum is a wonder in itself, there is no doubt that the main object of wonderment, and almost awe, is the electric whirling stage. It is delightfully exhilarating to watch it from the auditorium, but the real marvel strikes one when standing beside the man whose merest movement starts the mass, brings it to speed and as quickly tones down its mad flight until it comes to rest.

predecessor with hardly a sound. At back of the curtain it seems almost weird to find a complete scene, with costumed characters complete, awaiting the cue which shall whirl them to the foot-lights to come into view when lamps from all quarters are flashed upon them.

Below the great revolving stage, which is sunk deep in a well built to receive its supporting girders, one would expect to find a maze of wheels, levers, and all the adjuncts of mechanical motion, but no: just the opposite. To the uninitiated the tables have no visible means of turning at the speeds observed from the house, and with difficulty such may be persuaded that all is done by the few dark objects equidistanced around the great circle, and even when in motion showing no sign of their activity other than that of the whirling mass above them. The motors operating this unique stage are controlled by one man from a small gallery or rookery high on the wall



Behind the scenes at the London Coliseum.—Preparing for a great spectacle.

Brevities.

Modern electric railways run in tubes are remarkably free from accidents considering that derailment at high speed would probably occasion disaster. Automatic signalling is a prominent feature with these lines now, and if a train overruns the signals it can be brought to a standstill by a stop in the track, against which a depending rod strikes and cuts off the current, while at the same time applying the brakes.

* *

The Baker Street and Waterloo Railway will be opened shortly after this issue is in our readers' hands. It is five and a half miles long, and will be the latest addition to London's now numerous tube lines. A colour scheme has been worked out for each station so that passengers can distinguish their destination unless they are colour-blind or otherwise preoccupied.

* *

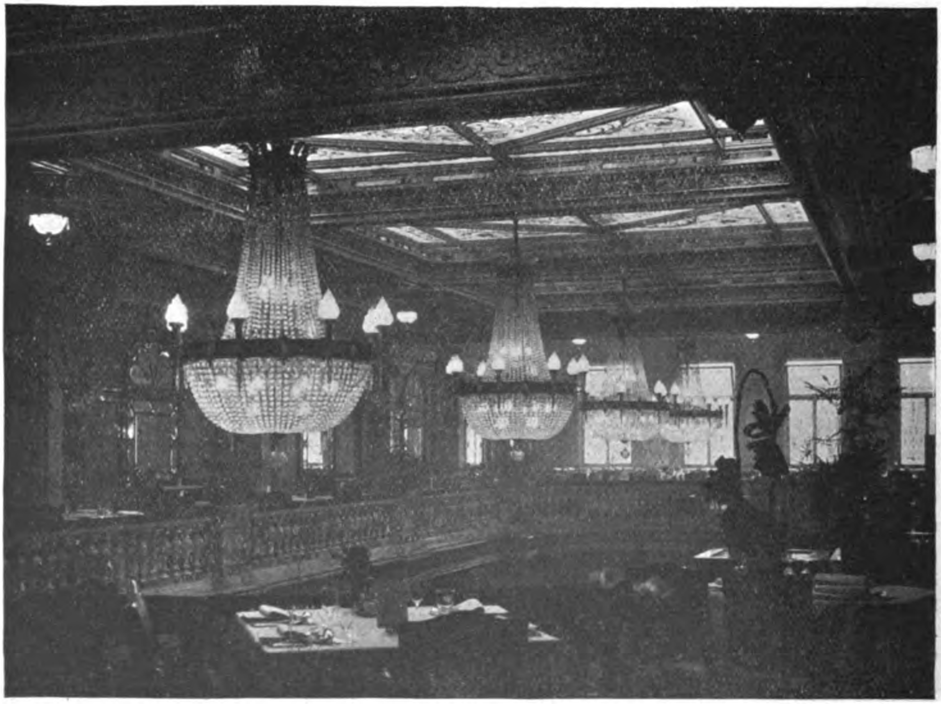
Concentration is now the recognised order of things. Compressed eatables and *multum in parvo* meals have quite become institutions, so it is not surprising to hear that London is to be supplied with compressed electricity—we mean this in the sense of concentration of effort in producing the energy rather than anything in the shape of a "toothful" of electric power. One or two huge stations, will, it is hoped, supply London with all the electricity it wants.

* *

"The first great change in the production of electricity will abolish the carrying of coal for that purpose. Instead of digging gross material out of the earth, loading it on cars, and carrying it, say, five hundred miles, there to put it under a boiler, burn it, and so get power, we shall set up plants at the mouths of the mines, generate the power there and transmit it wherever it is needed by copper wires."

* *

So spake Edison to a representative of the lay press. We are not getting it quick enough; that's the worst of it.



A typical instance of Interior Lighting by elaborate Electric Light Fittings. The depending columns, ornamented with glass, support Imitation Torches, which produce a striking effect.
(Illustration by courtesy of General Electric Co.)

Belgian Industrial Enterprise.

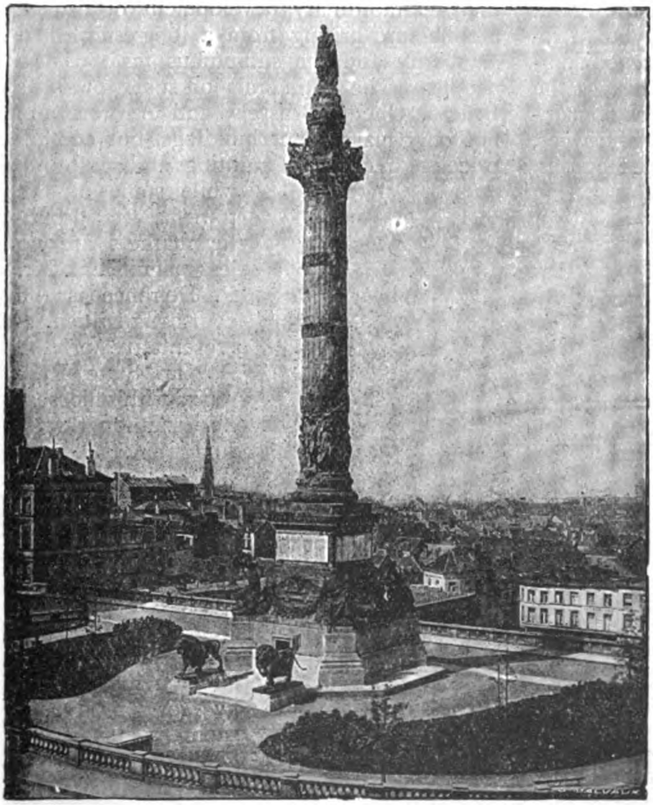
A COMPARISON of the Customs returns of various countries reveals the fact that, commercially, Belgium occupies the premier position as regards the value of imports and exports per 1000 inhabitants.

Comparatively unknown up to within half a century ago, merely on the threshold of colonial expansion, possessing no shipping of her own and compelled therefore to be dependent upon foreign transport for her over-sea commerce, Belgium may justly be proud of those efforts which have resulted in her attaining her present first-rank position in the world of economics. This result is attributable to the unflagging energy and commercial enterprise of her people and the confidence inspired by the good repute of her manufacturers and merchants, and lastly, to the world-wide reputation of her products.

Belgium's industrial activity is displayed in almost every direction: coal mines, iron works, copper mines, stone quarries, blast furnaces, steel works, zinc works, glass blowing, electrical works, sugar refineries, &c., &c. Belgian rails, Belgian rolling stock, window and plate glass, and other glass ware of Belgian manufacture are found in the markets of every country in the world.

Belgian capital is invested in innumerable foreign and colonial undertakings; railway concessions are held by Belgians in Egypt, China, Persia, &c. It has been calculated that no less than 140,000,000 dollars of Belgian capital have been sunk in developing and working the vast natural resources of the Russian Empire, this sum representing the aggregate capital of the 105 concerns of Belgian origin in that country, of which 43 relate to the operation of coal and iron mines, petroleum wells, or various metal and glass works, while 16 relate to tramways.

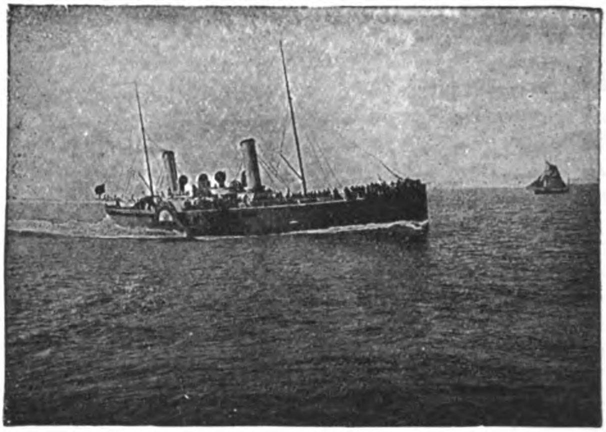
Another fact illustrates in a striking manner the enterprising spirit of the Belgians: Belgium was the first European continental nation to establish a railway, and in proportion to her area she has now a greater mileage of railways than any other country. The greater portion (2530 miles) of her railway system is under State management, and the low scale of fares in operation may be gauged from the fact that for a sum barely exceeding 2 dollars a season ticket can be obtained covering journeys on the whole system in any direction during a period of five days. A similar ticket for a period of fifteen days costs less than 5 dollars; whilst for an expenditure of 25 cents daily it is possible to travel for a whole twelvemonth at any time (day or night)



Statue of Rubens and Cathedral, Antwerp.

upon any part of the 2530 miles of the State Railways.

An express service of up-to-date steamers runs between Dover and Ostend in connection with the State Railways and connects England with the Continent. This is also State owned and State managed. Such facilities as these make it just to claim that for English and American travellers no country is so easy of access as Belgium.



Turbine Steamer, "Princess Elizabeth."

The country is divided into two distinct regions, the western and northern portions being made up of wide plains which, especially in Flanders, are of unequalled fertility; the inhabitants are of Flemish race and language. To the east and south, where the Walloons are to be found, is a land of wood and mountain, with escarped cliffs, mysterious horizons; the grand valleys of the Meuse, Lesse, Houyoux, Amblève, Ourthe, Semois and the rugged summits of the Ardennes ranges. This, in the present day, is also the home of various industries, such as coal mines, smelting furnaces, iron foundries, glass works, machine factories, and the like, while Flanders still maintains the arts and fabrics for which Flemish towns have so long been famous, no less than for their extraordinary development of artistic architecture arising from a long-established prosperity and the sumptuous taste of the people. The cathedrals of such towns as Bruges, Ghent, Brussels, and Antwerp are not only magnificent buildings, but contain priceless treasures of paintings and sculpture, while some of the town halls and public markets are no less magnificent. Mr. P. Defrance is the courteous British representative of the Belgian State Railways, with offices at 47, Cannon Street, London, E.C.

Canal and Old Church Tower, Bruges.

* * *

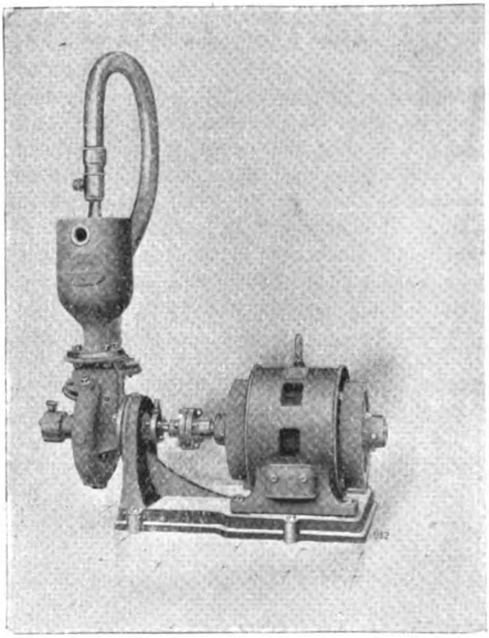
A correspondent writes regarding POPULAR ELECTRICITY: "I congratulate you most heartily for producing such a sparkling 'Trade Booster.' This is, indeed, a step in the right direction."

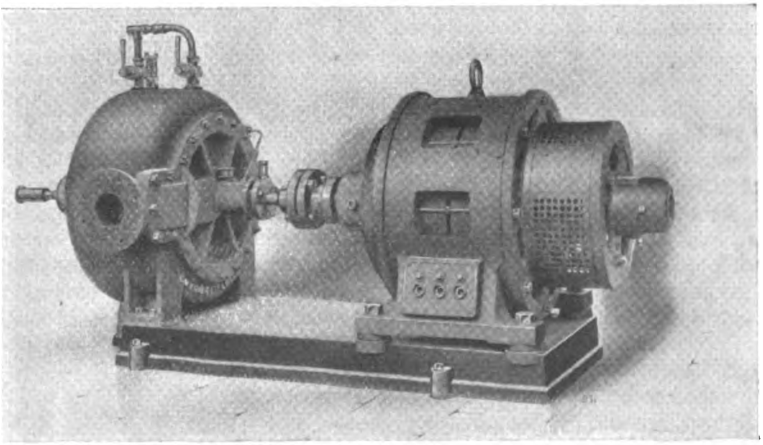
Electric Pumping.

We referred last month to some of the things the small motor could do. Now we want to point to its ability as an agent for water-raising, though we will take it in a small way first. The bigger things are quite as easily done by the motor, but for our purpose a start at the beginning is best. Because the electric motor is a rotary machine, and for that reason is compact and light, it follows, most naturally, that a pump connected to it shall also be of small proportions and the opposite of elephantine in appearance. Rotary pumps have for years been in existence, but their real value was only proved when they could be coupled direct to the driving mechanism as you see them in the illustrations on this page.

The direct-connected electric pump must be seen and tried to be appreciated. In country residences or on farms where a supply of electricity is available, as it often is, the electric centrifugal is an invaluable aid to the multifarious operations needing water. The labour and time spent in carting water over great distances can be obviated if power is at hand to operate electric pumps of the simple rotary kind.

It is not our intention to go at the moment into the cost of an installation of this kind, but we can confidently state that many thousands of such pumps have been built and are giving every satisfaction to their users. It is not difficult to see why this is so, for a glance at the types illustrated herewith, even in picture form, gives the idea of simplicity and efficiency. It is on the ground of simplicity that this kind of pump gets the pull over one employing plungers, rams, cranks and gear-wheels. All the needless adjuncts of reciprocating motion are done away with by the simple electric.

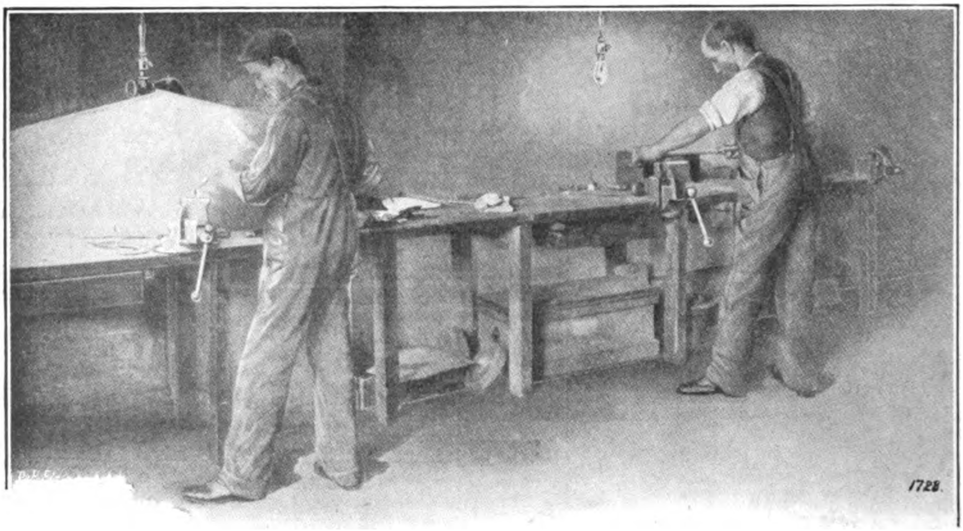

A Tiny Pump and a Tiny Motor Suitable for Duty as a Portable Water Supplier.


A Larger Electric Pump which Makes a Compact and Useful Article for Country House and Farm-Use.

Efficient Lighting.

THE day of the tallow-candle is gone, as some wiseacre may tell you, and on the face of it you've got to believe him. Still you will opine that even the humble dip can be held up to some bad forms of modern illuminants. You might even supplant your bedroom electric lamp by the lowly candle if a convenient incandescent reading lamp had been obligingly omitted from the wiring system.

What we are driving at is the need for efficient lighting; the putting of a lamp just where it is needed and nowhere else. When that is done one thing remains; the provision of that lamp with a suitable reflector, so that the maximum of light will find its way to the desired point of use. Our illustration on this page makes the thing perfectly clear. It is an admirable example of a negative and a positive effect. The man on the right is at a disadvantage because the lamp over his vice is distributing its light in all directions instead of where he most needs it. His neighbour, meantime, is blessed with an efficient reflector which gets all the use of the lamp for his benefit and, of course, adds to the ease with which he can work.



The Primitive and Scientific Sides of a Lighting Problem.
The man on the left looks as if he had the best of it.

The lesson applies outside the workshop, though for the purposes of illustration we have selected that particular spot. A drawing-room, a study, library, desk, or armchair may be lacking in just those points which make for effective and therefore efficient illumination. The means are to hand for the accomplishment of this ideal in lighting, both as regards the illuminant itself and the method of best directing its rays. Reflectors, diffusers, and concentrators are simply pouring from the factories of makers, so there is no excuse for lack of material. Hitherto there has been a dearth of experts who could advise on the best method of lighting rooms of all kinds, and whose recommendation could be relied upon, but that is now a thing of the past. What is known as the "illuminating engineer" is now in our midst, and in his keeping are the ideas which shall give us efficient lighting.

As soon as he gets a move on things will begin to brighten up a bit.

POPULAR ELECTRICITY.

A JOURNAL OF ELECTRICITY SUPPLY AND GENERAL ELECTRICAL INFORMATION.

Price, 1d. By Mail, 1½d.

Popular Electricity can be obtained from—
The Publishers,
The Electrical Publishing Co., Ltd.,
4, Southampton Row,
Holborn, W.C.

It is also procurable at the principal Electricity Works in the United Kingdom, with which special arrangements for distribution are being made.

EDITORIAL DEPARTMENT.

Communications of an Editorial nature to be addressed to The Editor, 49, Mildred Avenue, Watford, Herts.

Original contributions will be considered at all times, and if published will be paid for at column rates. MSS. should be accompanied by stamped addressed envelope, and should bear name and address of author.

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THE MOST REMARKABLE, most useful, and most interesting periodical to-day dealing with electrical matters is The ELECTRICAL MAGAZINE. Each issue contains from 100 to 200 pages of valuable matter splendidly illustrated. It is a journal which every man interested in Electricity and its applications should take. A single copy will be sent by the publishers for 9d. in stamps, or it can be purchased for 6d. on the bookstalls, or ordered through your newsagent. Address: 4, Southampton Row, London, W.C.

Our First Number.

The first issue of POPULAR ELECTRICITY has met with a most enthusiastic and encouraging reception at the hands of the press and electricity supply interests throughout the country. Its appeal, its style and its general arrangement have been fully appreciated, and we are persuaded of the genuine merits of the purpose we have in view in instituting this novel departure in electrical journalism.

We hoped initially to meet with some response from the great interests which it is our intention to further with this journal, and our most sanguine anticipations have been more than realized. POPULAR ELECTRICITY has "caught on" and will continue to grow in favour because it is *really popular.* From all quarters we have received congratulations on this score.

* *

Sparklets.

Up to the moment of going to press we have had to meet no claims for compensation as the result of shock from the issue of our first number. We must at this juncture repudiate any notion which may gain prevalence that we reimburse readers for the loss of any animals, domestic or otherwise, guilty of consuming our pages.

* *

Protection may be "dead and damned" in this country, but we all know it exists in America. The next thing they are protecting there is Niagara Falls! Too much water is being drawn off by the power companies, and the Falls may be left high and dry. One would have thought those falls could have retaliated without the need for protection. Perhaps Mr. Balfour will offer his services.

* *

An hydraulic water main burst in St. Martin's Lane, London, recently, and at once pavement and street were upheaved and fountains of water burst into the road. Theatres, which abound in the district, were seriously inconvenienced in those cases where hydraulic power is used to raise the curtain. Those employing electricity were unaffected by the accident. The main burst at 2.45 p.m. and was not isolated until 5.30 p.m. Think of it!

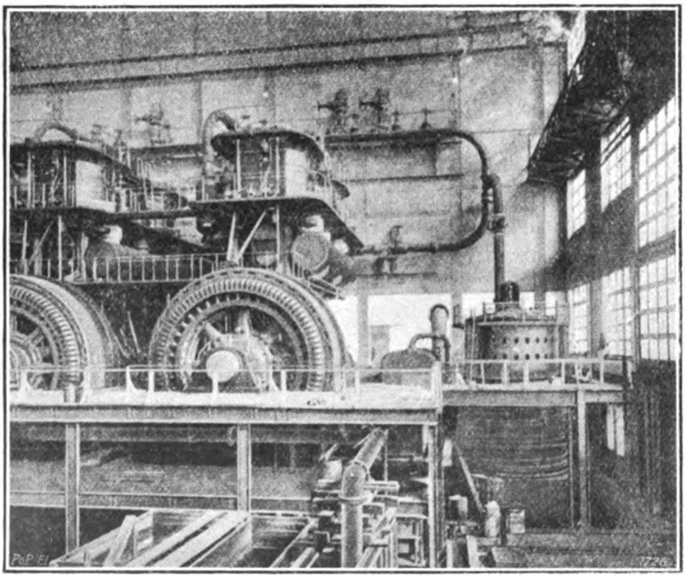
* *

Telephone bells nowadays bring a scowl to the brow and something else to the lips. Such a horrid nuisance, don'tcherknow! Herr von Bülow did not think so when, after a masterly piece of diplomacy with Spain, his telephone bell rang: "I am ordered to inform your Excellency that His Majesty confers upon you the title and dignity of a Count of the German Empire!" You're not Count von Bülow? Yes; we know that, but he didn't know he was in luck any more than you do. The point is, if you have not got a telephone, try your luck with one.

Reliable Service.

Any public supply of no matter what commodity is liable to interruption at some time or other. The tendency, however, is to reduce the stoppages to a minimum, and in the case of electricity that is generally assured by simplifying the apparatus at the power-house. One time heavy reciprocating steam engines, such as can be seen in any mill or on a steam-boat, were used to drive the electric generators. These were unreliable because they comprised so many parts likely to get out of order. Of course they did good service, and many hundreds of them are in operation to-day, but the call for complete immunity from breakdown has brought into being the practical steam turbine which, by its simple rotary motion, relieves the mind of the engineer from anxieties about cylinder covers, pistons, cranks, &c.

Generators of this kind also took up a lot of room, and if a glance is taken for a moment at the engines on the left of the adjoining illustration it will be seen that the structure has a very massive appearance. The handrail is a good guide to the height of the engine and generator. Now the big fellows on the left develop about 8000 horse-power, and as we have said want plenty of room, while they also take time to erect and are in addition very costly. Some eleven of them were put down in a station which was to hold sixteen, but by the time the eleventh was put down the steam turbine had been commercially produced and was found absolutely reliable. The station engineers, therefore, decided that the remaining units should be of this type, and one is shown on the right of the picture in the corner, where it looks the picture of insignificance. It isn't really, because it can develop 2000 horse-power more than the monster which looks almost disdainfully down upon it.



A contrast in Electric Generators. The monsters on the left are not so powerful by 2000 horse-power as the small turbo-unit in the corner on the right.

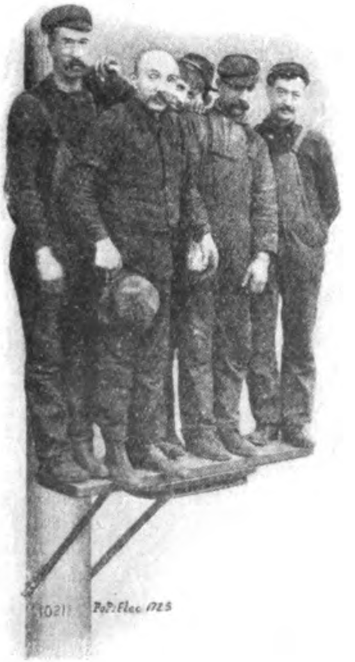
What does this mean? Why, just the two words at the head of this short note: reliable service. The installation of that "diminutive giant" gives the engineer a greater claim on the consumer of the power and light he generates by this means. He can take a man who wants light from him, say, and show him that unit beside the others, and at once his confidence in the system will be assured. Even if he is not an engineer and cannot appreciate the points of the two machines, he will see that the simpler is the better and, therefore, to him the more valuable, because of its reliability.

Simplicity spells reliability in these days, and the most ordinary mind can understand that the fewer the parts of a mechanism so in proportion will the liability to failure be. This applies to everything around us, and with electricity supply the commercial welfare of so many individuals depends upon the reliable character of the service.

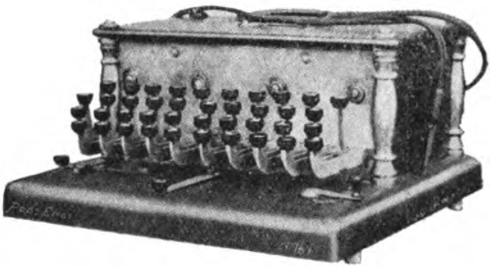
Telephone Linesmen.

The happy-looking crowd on the narrow ledge shown in the picture are not inhabiting a new home for the unemployed. They are just testing a linesman's pole-seat to demonstrate that it will stand any strain put upon it. Linesmen of course vary in weight, and the test must be for the heaviest man who will entrust his life to the telephone pole when at work. We do not often see men seated on high poles in this country, as they appear to trust to leg irons and the cross arms of poles. At any rate in the case depicted the material looks to be bearing up under an exceptional strain, though the makers contend that more men could have been got on the seat, only they feared an injunction for overcrowding.

Speaking of linesmen makes one think a little of their position in the ranks of labour. A man who will, as linesmen do regularly, expose himself to the dangers and inclemencies of the elements is, after all, as much a hero as any Jack Tar. We may yet come to hail the telephone and telegraph linesmen as subjects for the Poet Laureate's pen.



Testing the Seat on a Telephone Pole, to ascertain its bearing capacity.
The makers claim that more men could be got on the seat if there were room.



A modern Typing Telegraph Instrument, which does away with the fatigue of a Morse Key.

Telegraphic Typewriting.

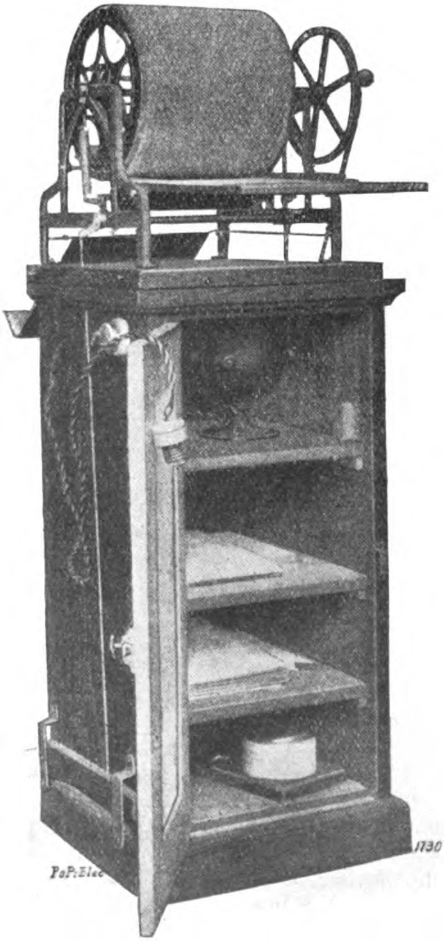
We are now all familiar with the tick-tack of a Morse key and of a telegraph operator pushing and pulling—that does not describe the action correctly—his handle under a needle pattern instrument. In his mind the message is translated into the Morse code, by which it is conveyed through the medium of hand and key to the telegraphic circuit. Very extraordinary speeds can be obtained in this way, so one cannot but feel that the physical strain is very great and that greater proficiency could be obtained by employing keys for every letter which, when depressed, will transmit the Morse code to the line. Typewriters are now available for this purpose, and systems employing them are in use over long lengths of telegraphic line. The instrument illustrated above will send Morse signals over a line if the keys corresponding to certain letters are depressed. The downward movement of the key causes the completion of the circuit for longer or shorter intervals to give the dashes and dots required. The makers claim that higher speeds can be obtained and less fatigue is noticeable with this machine.

Machine Telegraphy.

The machine telegraph has been with us many years, but attempts at pushing it beyond a certain point have met with little success. Telegraph operators suffer from the fatal disease of withstanding encroachments on their special domain. But for their extraordinary proficiency, they would have been superseded long ago. Still, the situation is so far changed that, before many years elapse, either machine telegraphy will be in vogue or the advance of the telephone will limit telegraphy to a comparatively narrow sphere.

A Motor Copier.

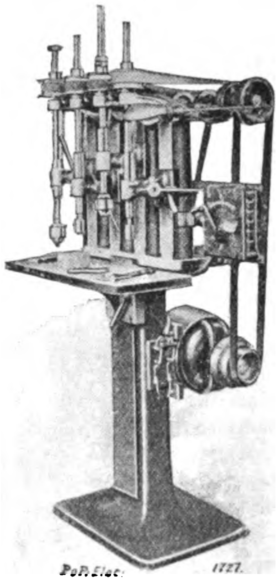
Every office now has a copying apparatus of some kind, and useful little articles they are. The duplication of letters, circulars, pamphlets, &c., is made possible, both cheaply and efficiently, by this simple piece of mechanism, and, as the picture below shows, the output can be considerably increased by the use of the electro-motor. It is hardly distinguishable in the dark recesses of the cupboard, but that is its chief feature. It takes up little room and will work out of sight without attention. As will be seen, a lamp-holder socket serves to furnish the requisite energy, which is very small for the work done.



The Motor and the Copier.—The tiny black object on the top shelf of the cupboard is the motor.

The Multiple Electric Drill.

A compact drilling outfit complete with electro-motor and starting switch is that illustrated below. From a workshop point of view it is portability itself, while in the matter of efficiency and speed it has no equal. The drive is by strap from the motor to a countershaft, and thence by short belts to the drill spindles, which are slotted to allow of the descent of the drill through the work. An outfit of this kind should find a place in every small workshop, especially if much drilling has to be done. The four spindles admit of the use of different size drills, and, if care is taken, taps can be used for screwing purposes. A lamp with special reflector to throw light on to the drilling table will also be noticed on the near side of the drill pillar. No engineer need ever regret finding room in his workshop for a tool of this kind driven by the handy electro-motor. The local electricity supply concern will give full details of the cost of operating an outfit of this kind, but it will be a lot cheaper than gas or steam.



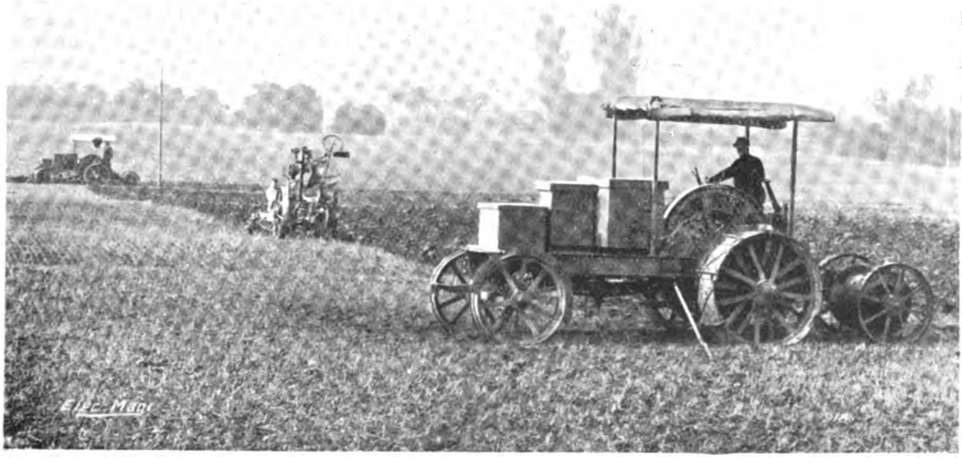
A complete Electric Drilling Machine, with four spindles, motor and starter, are all included, so that the machine is the acme of portability.

Industry and Agriculture.

WHAT a singular contrast is presented by these two extremes of human affairs! How irreconcilable they both seem at first blush, yet how closely are they not linked together! It must strike the most ordinary observer, however, that industry has too much of a share in the fruits of modern invention, while agriculture is left to drag itself along with such crude implements and what few mechanical aids to labour are vouchsafed to it. Things are at present quite disproportionate, and some movement is needed to put the conduct of agriculture on a better footing beside its more powerful ally.

Electric power has practically changed the entire face of industry—washed it, one might almost say, or, at least, is washing it, from the soot and grime of steam. Industry has taken electricity as partner for better, for worse, and, judging by appearances, is not dissatisfied with the bond of union. It is not expecting too much to hope that before many more years elapse—years, mind, not decades—electric power will have taken the place of steam in the great hives of industrial activity.

Now, where does agriculture come in? Surely something must be done for the farmer, who is, according to statistics, feeding, by his individual labour, seven industrials. Are his operations in field and meadow to go unattended by the fair Electra, who has been so easily won by a far less wholesome wooer? We hope not. Already the farming interests of the Continent, of Canada, and of Western America are awakened to the advantages of electric power as obtainable from water-power stations adjoining the land they till. Electric ploughing, pumping, and threshing are commonly undertaken in some districts, and communities of farmers consolidate to furnish or hire the necessary apparatus. We illustrate an electric plough in actual use. The picture represents a scene on the Continent on the fertile slopes of the Western Alps. The power for the gears hauling the plough, carried backwards and forwards, is being generated in the mountains far away by the water coming from the ice-fields and snow-capped peaks. We must convert our coal in the same way into transmissible energy for the farmer.



Ploughing the Fields with Electric Ploughs.
The shares are carried by the bogie, which is hauled back and forth by the two tractors, receiving their energy from the wires carried on the pole in the distance.

Figure it out.

What time you spend in looking for matches to light the gas?

◆ ◆

Whether it is worth while to spill oil on the carpet when electricity is waiting outside to cast its spell over you?

◆ ◆

Why the hall gas was turned out when you came home at 2 a.m., and why in your indecision to go upstairs in the dark you broke your nose against the bannister?

◆ ◆

What is it makes home happier, faces brighter, the country nearer, and life worth living? (Don't say "Not gas" before you pause to reply.)

◆ ◆

Why our article on page 18 is not a description of a gas works, a sewage farm, or a L.C.C. steamboat? (Send your answer to our Grand Inquisitor.)

◆ ◆

What draft you make on the hot part of your vocabulary during the year when using gas fires, and how much balance the gas company returns you on the strength of it?

◆ ◆

Which looks better, smarter, more at ease, a lady in an electric brougham or a country yokel on a motor 'bus? (or *vice versa*).

◆ ◆

Why you can't take a gas radiator to bed with you on a cold night, and a lovely little bit of lamb's wool connected up to the nearest lamp holder puts you in the seventh heaven of dreamland in a trice?

◆ ◆

Why it is dangerous to ask the gas meter inspector if he can drive a motor car, or push a handcart, or sweep a crossing at some future period in his luminous career?

◆ ◆

Why electric trams keep going in "sluggy" weather and motor 'buses cannot keep off the side walk?

◆ ◆

When the landscape will no longer be disfigured by such unsightly objects as gasometers and smoking retort houses.

◆ ◆

What will make London the best transport-served city in the world in twelve months' time?

◆ ◆

Why, a push-button lift does away with an attendant and takes you to the top of a sky-scraper before you can say "Jack Robinson"?

◆ ◆

Why it hurts when you pay a long gas bill, and why you smile at the electric light account?

◆ ◆

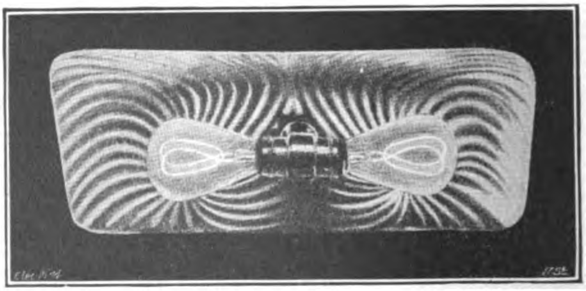
Whether you will die young with the mantle of gas over you or live to a good ripe age resting on an electric staff?

◆ ◆

What the Central London Railway would be like if a two-hours' service of steam trains were run through it?

◆ ◆

What this reflector below would look like with two batswing burners flaming under it?



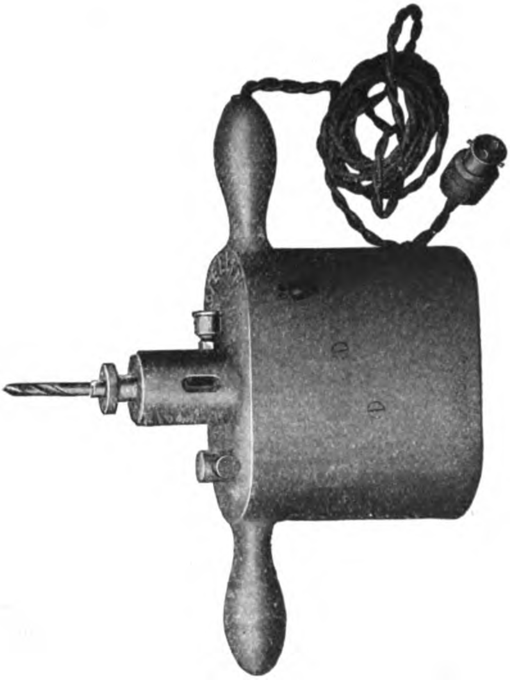
A Typical Reflector, with two Incandescent Electric Lamps.

Things you ought to Have.

You may always turn to this page for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

The Electric Hand-drill.

Once on a time the heaviest work was taken to the drill—electric power reverses this process and brings the drill to the work. Some drills weigh a few tons, but they are hauled there just the same. The youngster depicted here will work off a lamp holder socket, and with a vengeance too! Try one. The Electric & Ordnance Accessories Co., Stellite Works, Birmingham, will send one on trial.



* *

Cigar-lighting.

Matches begone! Tapers avaunt! I now use "The Electric" to light my weed. Do you? If not, send a p.c. to the Electrical Co., Ltd., Charing Cross Road, W.C., and you will get particulars of the one illustrated opposite.

This is not a pop-gun, but a modern Electric Cigar Lighter. You should use one.

Electrical Impulses.

Things would have been different if Electricity had lighted the station, but our poet just adores gas, hence the following effusion:—

I waited for the railway train,
The gas was low and dim ;
It came at last, and from the car
There stepped a dainty dame,
And looking up and down the place,
She straight upon me came.
"Oh Jack!" she cried, "oh, dear old Jack!"
And kissed me as she spake ;
Then looked again, and frightened cried:
"Oh, what a bad mistake!"
I said, "Forgive me, maiden fair,
For I am not your Jack ;
And as regards the kiss you gave,
I'll straightway give it back."

It's just like our poet to add that:—

Since that night I've often stood
Upon that platform dim,
But only once in a man's whole life
Do such things come to him.

* *

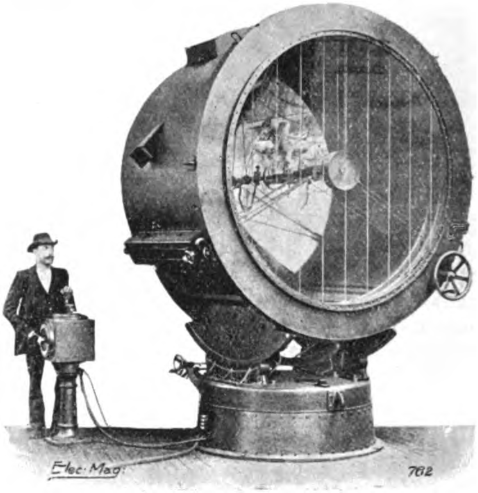
"What's the matter?" asked the up-to-date electric man of the old dodger always behind the times.

"Why," was the answer, "I saw the other day that in 60,000,000 years the sun's light will give out, and if my grocer gets to hear of it he'll put up the price of paraffin."

* *

Jones (at telephone): "Hello! is that you, Smith?"

Smith: "No, I am not myself to-day."



A monster Electric Search-Light which can be seen 28 miles at sea.

A bibulous wireman went to the photographer's.

The artist asked, "Will you have something to drink?"

B.W. "With the greatest pleasure."

Artist snaps him and takes no further notice.

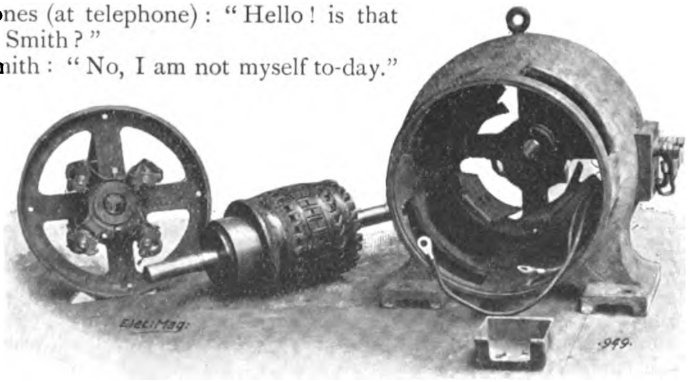
B.W. "Eh, mister, what about that drink?"

Artist: "That's only a trade ruse to obtain a perfectly natural facial expression."

B.W.: ? ? ! ! ? ? ? ! ! !

(Another artist, please!)

* *



An Electric Motor pulled to pieces.

The little cylinder in the middle is the business department of the concern—it does all the moving.

Customer: "Hum! so that's what you call the Telautograph?'

Salesman: "Yes marvellous machine, Sir. If you can't spell a word at any time, it makes a blot!"

* *

Engineer (to his wife): "Didn't I telegraph you not to bring your mother with you?"

Wife: "That's what she wants to see you about. She read the telegram."

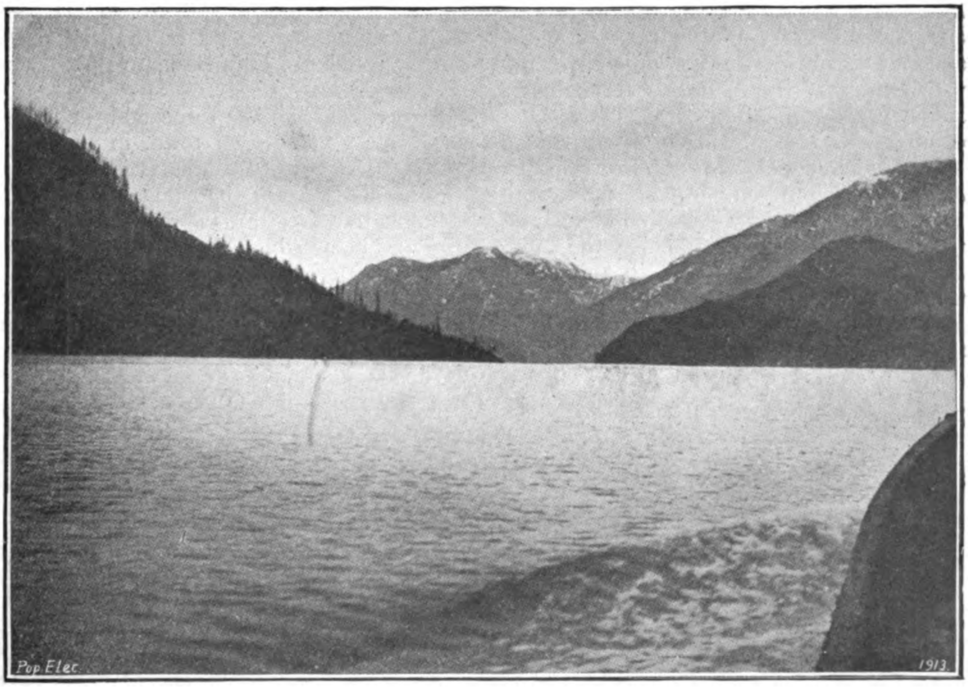
PROFUSELY ILLUSTRATED. ONE PENNY.

POPULAR ELECTRICITY

Power from the Mountains.

In these few lines we want your attention. A new method of giving power to man is being developed, and you should know just a little about it. For many centuries he has delved and dug to bring coal from the heart of the earth to meet his needs and do his bidding on its surface, and people are now accustomed to this form of concentrated light, heat, and power. They cannot well conceive of a warm room without a coal fire or a coke stove, and the very idea of heat is at once coupled with that dusky substance.

But electric power is changing all this. Away in countries bounded or lined with snow-capped mountains there is water high up above the sea. That water is latent energy, and, if guided and controlled, will give of its force to produce electricity on its way to the ocean. Swift-running water-wheels line the path of its headlong rush, and sturdy dynamos driven by their aid deliver power which can be sent over miles of wire to the distant city, where tram and train, lamp and motor yield up to man the power of the water from the mountains. What a harvest of power is in store for nations blessed with range and peak, crag and mountain top! and how paltry coal will seem in years to come.



A mountain lake, fed by the snow-clad peaks around, which will generate electric power for a city 100 miles away in the valley below.

Sixty Miles of Electric Cable.

Sixty miles seems a respectable distance to compress within the compass of a few lorries with their horses. It is not by any means the essence of concentration, as many miles of fine wire will take up but a few inches. But sixty miles represents the length of the cables reeled on to the drums which you see in these pictures. Every day of your life, if you live in an industrial district or a town running an electricity works, you will see the cable trolley plying the streets, but the process of manufacture will of course be a mystery to you.

In a few words we can tell you something about a type of cable which is largely used to-day, the paper-insulated, lead-covered cable. This cable exists by reason of one thing, and that only—the high cost of india-rubber. If the price of this commodity could have been kept down, electrical engineers would never have had to resort to anything but the rubber-covered or insulated wire. Instead they wrap the copper wire round with special paper, in tape form, and impregnate it with a heavy oil or specially prepared compound largely composed of oil. To keep the paper coating, which may be about ¼in. thick, free from moisture, and to help it retain its saturated condition, it is enclosed in a sheath of lead pressed tightly and uniformly on to it by hydraulic pressure. As it leaves the press it resembles a lead pipe of large or small diameter according to size, but of course it is much stiffer, though it is even then very flexible and can be easily handled. In this state it is ready for active service. It comprises the centre core of copper, a ring of impregnated paper, and the outer ring or tube of lead.

Many thousands of miles of cable are laid beneath our roads and pavements, and the passer-by little dreams of the networks over which he complacently treads. In a city like Manchester there are 164 miles of feeders alone; that is, of cables run from the stations to the network or supply wires. The latter are laid in 128 miles of streets, and their total mileage would be from six to ten times this figure, because many more wires are used.

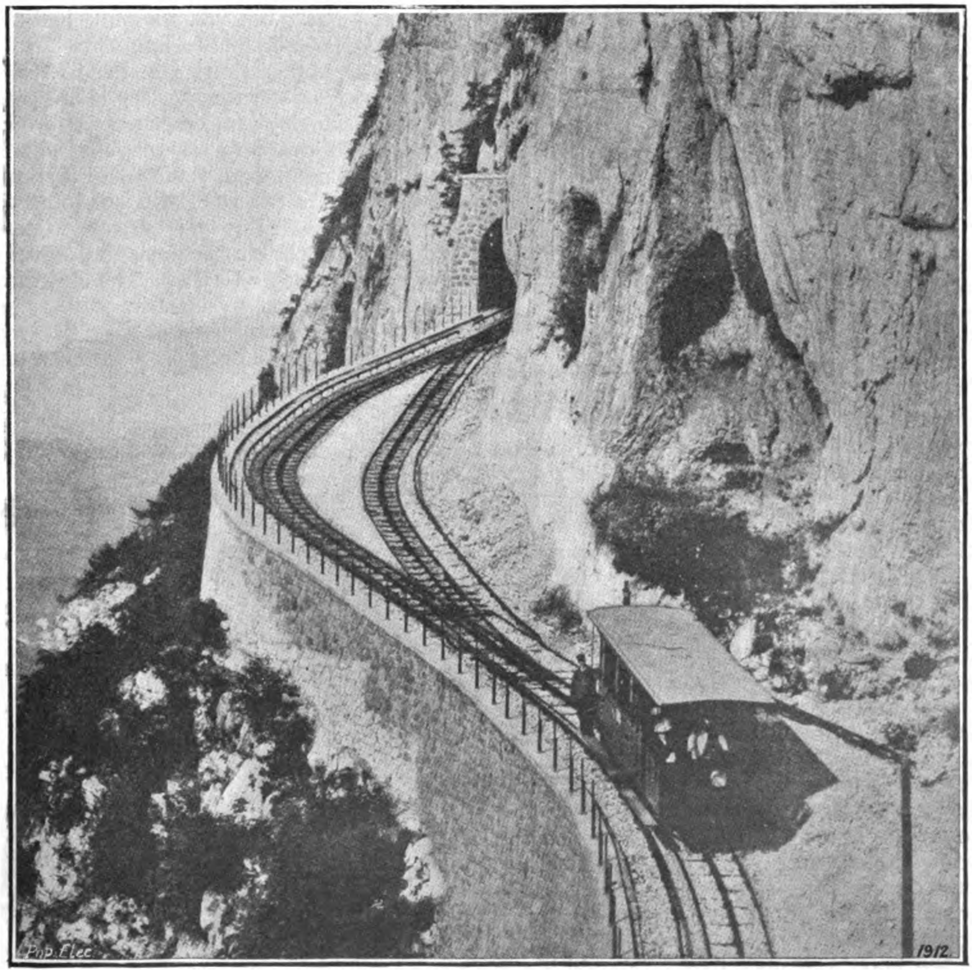
Sixty miles then is a respectable length of cable for a good-sized town, in the neighbourhood of 250,000 inhabitants, say, and this comparison will give you an idea of the contents of the drums depicted on this page. The cables in question are for H.M.SS. *Achilles* and *Cochrane*, and they were made and supplied to the Admiralty by Messrs. Connolly Bros., Ltd., of Manchester.

The two photos above are of 30 miles each of electric cable leaving the makers' works.

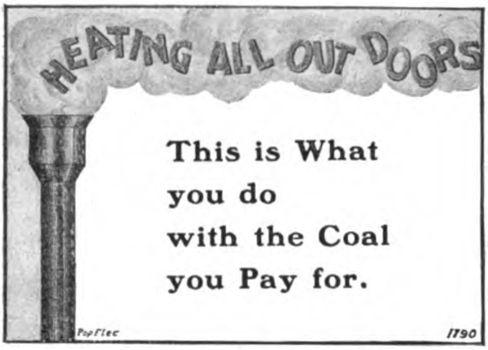
Electric Mountaineering.

We have relinquished the glories of struggle and strain up escarpment and cornice for a comfortable seat in the electric or cable car which glides with us to the dizzy heights of the white-tipped Alps. On our way we gaze out over lovely stretches of country, or into giddy depths fringing the line on some curve or slope. A party of climbers will, so we think, look eagerly at us as we smoothly pass their resting-place, though in reality they hurl after us epithets, which, could they but materialize, would burn up the motors under the car.

But we are not all enthusiastic acrobats, and must call in science to whisk us to the heights which daring and hardship could alone previously attain. Before long all the Alpine solitudes will be broken by the grinding of wheel on rail, and the scream of whistle and brake, and the mountaineer will be driven to the other side of the peak or to spots where even the engineer will not think well to follow him. Still there is a charm in the ascent of the electric car with its merry load, and we bless the science and skill which makes its journey swift, safe, and comfortable.



Scene on a Typical Curve of a Swiss Mountain Railway.


HEATING ALL OUT DOORS
This is What you do with the Coal you Pay for.
PopElec
1790

Just look at that chimney! A disgrace, isn't it? But it can't help it. It's there to carry off smoke, soot, and dust; but it takes something else with it—something you want, and have to pay for. What is that? Why heat, of course. You don't suppose that if you could sit in the chimney just above the fire-back you would be in an ice bath or a cold draught, do you? We haven't tried it; but you can take it from us that the Sahara is nothing to it.

After all you don't need to experiment, because you have been doing that for years, and, like all research work, it has cost a pretty penny. And you have paid and looked pleasant.

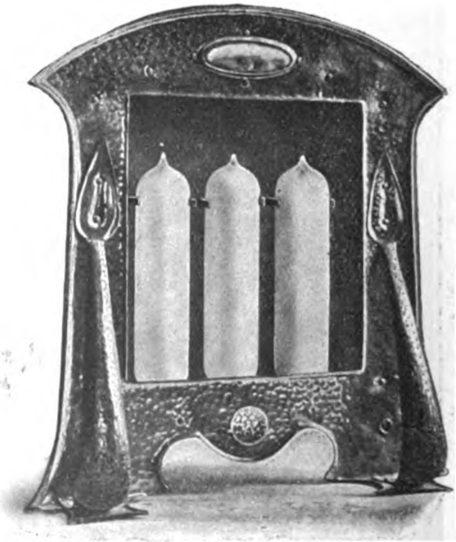
The end and aim of coal-heating is summarized in that smoke stack at the top of this column, "Heating all out doors." We expect you will say that was not what you bargained for, and that you do get a good deal out of what you pay for in the way of coal. Yes, you do; but when you buy a joint of beef you don't reckon on a lot of waste. You set that down at a minimum compared with the meals you enjoy from your outlay. True, you can figure accurately on the deal, and don't have to chase up chimneys after the wastage.

But look at it this way. You don't like being had with your beef, and why should you with the coal, or for that matter the gas, fire? You would be ready to knock a man down if he entered your drawing-room and told you in cold blood you were wasting your money, and putting it out foolishly. Still on the score of heat units delivered for capital invested, coal and gas are just awful speculations.

We know you cling to the dear old blaze, the crackle and the roar, and you think of an electric radiator, and say, "I couldn't—I simply couldn't—muse in front of that thing. Three glass bulbs looking stupidly up at me, tempting me to kick them because they have no soul and life and sparkle. You must take that thing to my great-grandson; he will appreciate it—I can't." This is what we fancy you will say.

But you know that electric radiator is coming to stay. A few half-pence knocked off the price for current will make all the difference, and you will then *have to* reckon which is better to patronize, the chimney stack and heat the air over your house (hopeless task), or install one of the little comforters depicted below, and rid your conscience of a stain for ever. It does not prick you now; but you are being had over the coal deal, and badly too.

There's another thing you musn't forget. The science of electric heating is not going to stop at the glow-lamp radiator. At present it offers you this form as the most suitable for the moment, and you should patronise its efforts to serve you. By so doing you strengthen the hands of research workers, and make it possible for them to produce a better and improved type. The electrician wants to give you an electric stove, filled with a substance which will glow like coal, but leave no smoke or smell. You can help him to do it.



"The Queen" Electric Radiator.
(By courtesy of General Electric Co., Ltd.)

We risk a lot in these days. We always did before, but more depends on it now than then. In industrial circles, for instance, how much hangs on the engine keeping up speed, turning regularly and constantly during working hours the wheels of the busy mill or noisy workshop. Risks increase in proportion to the complexity of the apparatus and the number of moving parts. An engine, for instance, whether steam, gas, or oil, is complicated because it can only be made to do, by roundabout methods, what a motor does direct. The engineer wants rotary motion; but with steam, gas, and oil, he must first have reciprocating motion (push and pull so to speak), and this he converts into rotary motion by means of piston, connecting rod and crank, such as you see depicted below. The engineer has always done it that way because it was the best for his purpose.

Now we have every respect for the engineer and his engine, but don't take chances with him or it. If you have to keep a shop going and are depending on a gas, oil, or steam engine, you *are* taking chances and we think you should shift your ground. You want rotary motion to drive your drills and lathes and boring mills, so why not get it direct, in pure, unadulterated revolutions per minute?

The electric motor has no humbug about it in the shape of valves, pipes, cylinders, cranks, and what not. It is just what this diagram shows it to be—a rotating business member with a pulley attached for a strap. It doesn't buck when you look at it and it won't "back fire." In a quiet corner of your shop, where the oil barrel now stands for your engine, it will stand and do all the work, and more, than that clumsy contraption of yours. Sorry to call it names; but "comparisons will come home to roost," eh? as some Irishman present may remark. But just think it out and tell the local electrical engineer he *was* right after all when he gave you advice about the steam engine you still use to drive your workshop. When you have power passing your door, why in all conscience should you keep stoking a boiler and putting your money into repairing an engine? In your heart you must know that the simple motor is best.

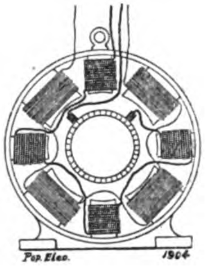
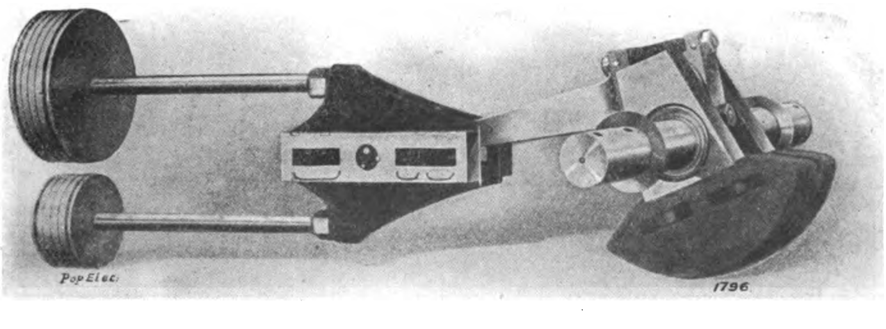
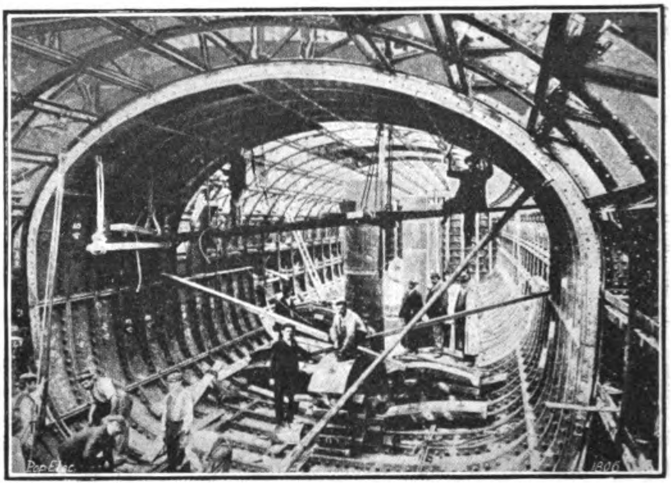


Diagram of a Simple Electric Motor. Just r.p.m., that's all.



One Limb of the "Push and Pull" Engine. The Pistons and Crank of a Compound Steam Engine.

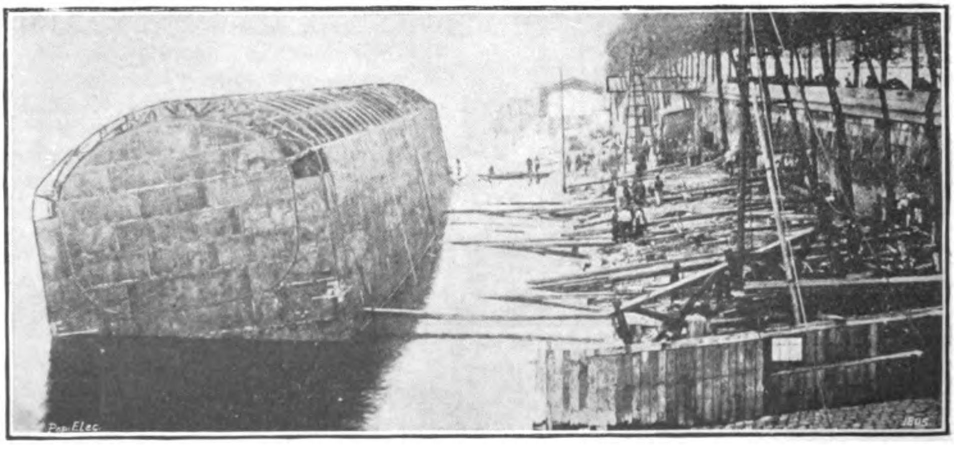
PORTABLE TUNNELLING.



The Portable Tunnel under Construction.

LONDON'S tubes are familiar to every Britisher and are now no novelty. To bore them beneath the Metropolis has been no light task and one requiring both care and time. For subsoil tunnelling the "shield" method will always remain, but subaqueous work is now to see a different method, which admits of the tunnel being built on land and sunk below the surface of the water. Paris is the scene of this development, and the first river tunnel constructed on terra firma will carry electric trains across the Seine. The illustrations on this page explain the thing exactly. The tunnel is built in sections constructed of steel frame and plates, and after partial construction is floated into the river. It is then roofed in, towed to its destination through various bridges, and then sunk in an excavation below the surface of the water. The sections, as completed, are butted together, and when all are laid the temporary end plates will be removed leaving a clear passage through the entire length. The first section is 115ft. long by 29½ft. high and 30ft. wide, and has been launched and sunk into position. Its weight is 280 tons. This method of constructing a tunnel dispenses with a large amount of tedious labour below the river bed and admits of a sound job being made of the steel work before it is lowered into position.

It affords a remarkable instance of the enterprise called into play by the employment of electric trains. Steam trains have never been successful in tunnels, and one cannot conceive of their extensive use in this direction.

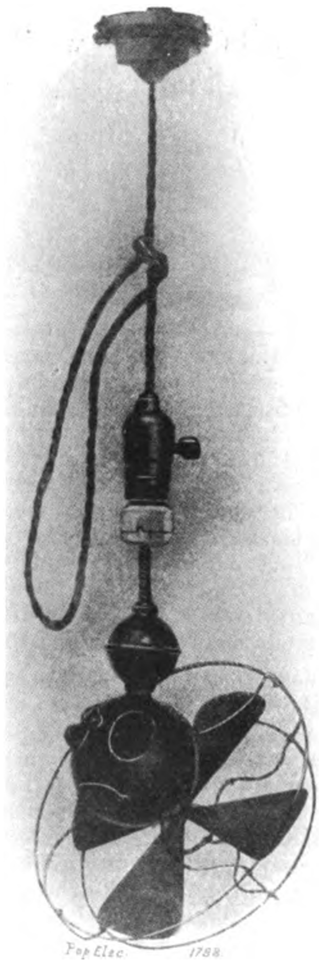


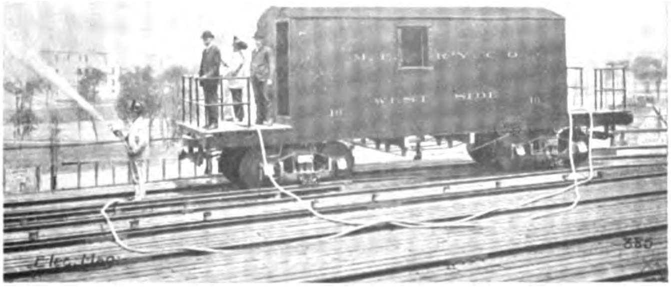
Portable Tunnel Floated into Position on the Seine

A WORD OF ADVICE—KEEP COOL.

BEFORE you know it the warm weather will be here and you will want to keep cool. Coolness and comfort in sweltering heat are more to be desired than gold, and a little consideration will put you right for the coming season. Don't be afraid to look ahead. You have a lamp-holder over your desk with a glow-lamp in it. It gives you light in the winter, but the summer sees it idle and listless, though it looks as if it could do business. In fact it can. If you take out the lamp, a small fan-motor can take its place, and you—well, you enjoy the breeze and raise a prayer of thankfulness for the blessings of modern science.

Seriously speaking, though, if you've got electric light, you simply must have that fan. Look at it opposite. It almost breathes on you.





Two forms of Electric Cooling. The Lampholder Fan above lowers the temperature of perspiring humanity, and the Electric Fire Hose on the left will damp down the ardour of the most ambitious conflagration.

Something to Make.

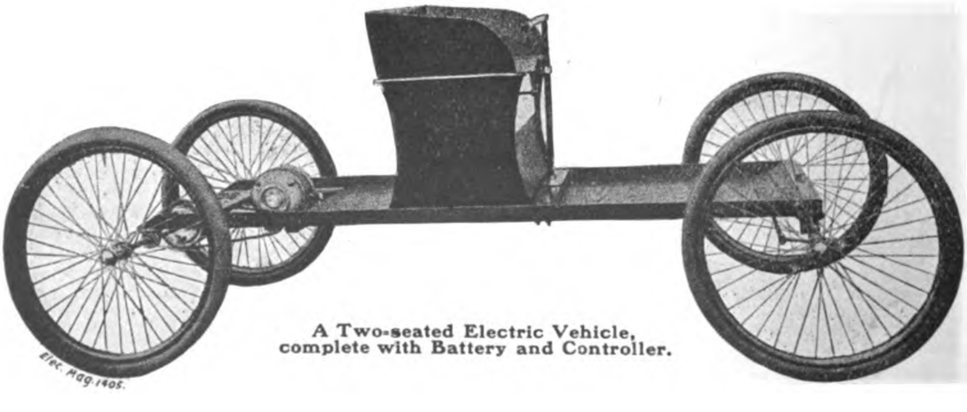
In subsequent issues we shall fill this page with handy notes on how to make certain useful electrical articles. As a preliminary we give a few particulars of an electric buckboard or two-seated car, which can be built up at small cost. A full description of all the parts was published in vol. iv. The Electrical Magazine (copies of which will be forwarded from Popular Electricity offices on receipt of 4s. or the bound vol. 6s. 6d.).

The vehicle here illustrated is of the buckboard type, in which the necessary cushioning effect, usually obtained by means of springs, is secured, partly through the resiliency of the tyres and partly through the use of a frame or platform which gives a considerable elastic deflection under load. This permits of dispensing with springs, and results in a much simpler and lighter construction all the way through. A single motor is used in connection with a differential or balance gear of simple construction on the rear axle. Owing to the extreme lightness of the vehicle and the consequent small power required to run it, it would be inadvisable to subdivide the power into two units with a resulting loss in efficiency. The battery used consists of twenty double cells, each having a capacity of twenty ampere-hours, thus giving eighty volts and twenty ampere-hours when coupled in series.

The controller provides three forward speeds of 3½, 7, and 12-14 miles and a slow speed reverse of 3½ miles per hour with the normal gear ratio. At the normal speed of 12-14 miles per hour, the machine is capable of running thirty-five to forty miles on one charge of the battery over good roads. With a change of driving sprocket any speed up to 20 or 25 miles per hour can be obtained without exceeding the one-hour discharge rate of the battery. Higher speeds than the normal are only obtained, of course, at the expense of efficiency, which results in a lower mileage due to the high discharge rate of the battery.

The outfit is designed particularly for city use over well-paved streets, and with this in view the weights of the various parts have been reduced to the lowest possible limits. The weights of the various items and of the complete vehicle are as follows :

	lbs.
Motor	38
Battery	170
Running Gear	122
Woodwork	45
Total	375



A Two-seated Electric Vehicle, complete with Battery and Controller.

POPULAR ELECTRICITY.

A JOURNAL OF ELECTRICITY SUPPLY AND GENERAL ELECTRICAL INFORMATION.

Price, 1d. By Post, 1½d. Annual Subscription, by post, 1s. 6d.

Popular Electricity can be obtained from the Publishers,

The Electrical Publishing Co., Ltd.,
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Holborn, W.C.

It is also procurable at the principal Electricity Works in the United Kingdom, with which special arrangements for distribution are being made.

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Original contributions will be considered at all times, and if published will be paid for at column rates. MSS. should be accompanied by stamped addressed envelope, and should bear name and address of author.

ADVERTISEMENT DEPARTMENT.

Business communications and advertisements to be addressed to 4, Southampton Row, Holborn, W.C.

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THE MOST REMARKABLE, most useful, and most interesting periodical to-day dealing with electrical matters is The ELECTRICAL MAGAZINE. Each issue contains from 100 to 200 pages of valuable matter splendidly illustrated. It is a journal which every man interested in Electricity and its applications should take. A single copy will be sent by the publishers for 9d. in stamps, or it can be purchased for 6d. on the bookstalls, or ordered through your newsagent. Address: 4, Southampton Row, London, W.C.

Sparklets.

POPULAR ELECTRICITY is like Charley's Aunt when she first made her bow to the public—"in for a big run." Electricity can move too when it shakes itself a bit!

* *

"Who steals my purse steals trash," but who appropriates telegraph wire gets the "copper." We hear (by wireless whispers) that forty wire thieves are doing time in the United States. They may more accurately be termed as "in the coils."

A correspondent in the East Indies sought information of Engineering recently upon the power derivable from the ordinary elephant for producing electricity by driving a dynamo. Our contemporary replied that a score of elephants walking round like mill horses in a station would be rather a painful spectacle, and apart from this would have suggested that the animals in question be trained to take up water and spurt it on Belton wheels but for lack of means of calculating the force of a jet of this kind.

* *

Some people are never satisfied. This is the sort of reply you may expect in a district fed on beer and skittles (liquid and solid) where you want to introduce electric light:—

> SIR,—Surprised that the Council's money should be wasted in exploiting the electric light business. No wonder rates are high. The half-starved, parish-damned, herring-gutted inhabitants of this soup-fed district will never be able to pay for the light if you are fools enough to supply it.

No, they want gas and oil for internal and external application. (We take this gem of a letter from Glover's 1906 Almanac.)

* *

An Ipswich lady sent the following lines on a post-card in reply to a circular from the electricity department:—

Oh, gas is a thing that's pernicious,
  It's poisonous, dirty, and dear.
Get rid of a system so vicious,
  Install our electrical gear.
Your folks will grow fatter and stronger,
  Your dogs and your pussy cats too—
So tamper with nature no longer,
  You cannot keep well if you do.

Spring-cleaning now looms in the distance,
  That dismal and desolate time,
And vain is the thought of resistance,
  So heed my mellifluous rhyme;
It's perfectly hopeless to break it,
  This ancient tradition of spring—
By starting our system you'll make it
  For once a delectable thing.

Commit these to memory and repeat them before the local electrical engineer. He'll allow you a rebate on the first 1000 units you use.

DON'T READ THIS

Pop Elec. 1908

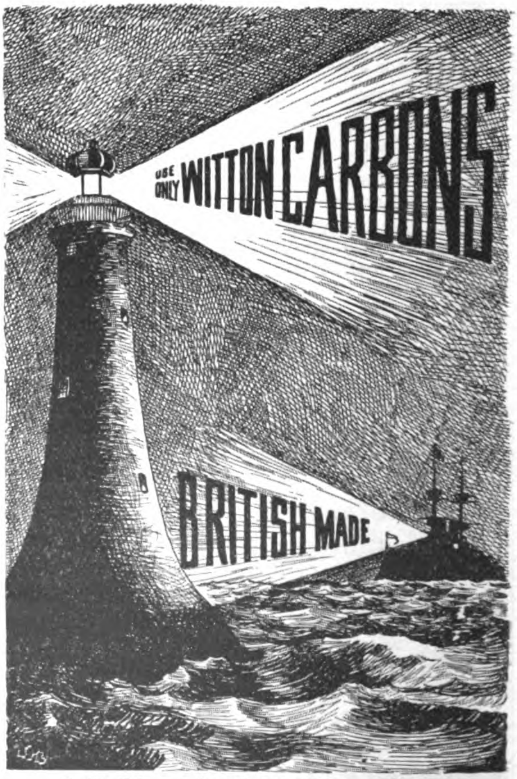
if your conscience pricks you or if you are in any way inclined to be unpatriotic. By unpatriotic we mean going deliberately out of the way of supporting home industry and enterprise.

You are familiar with the electric arc lamp, the light on high standards in your street, maybe, or in the public square. That lamp depends for its light on two rods or sticks of carbon some twelve or more inches long. There are many thousands of them in this country, and they are not only used for the streets, but also for shop lighting. Perhaps you have several in your establishment and know the custom they attract.

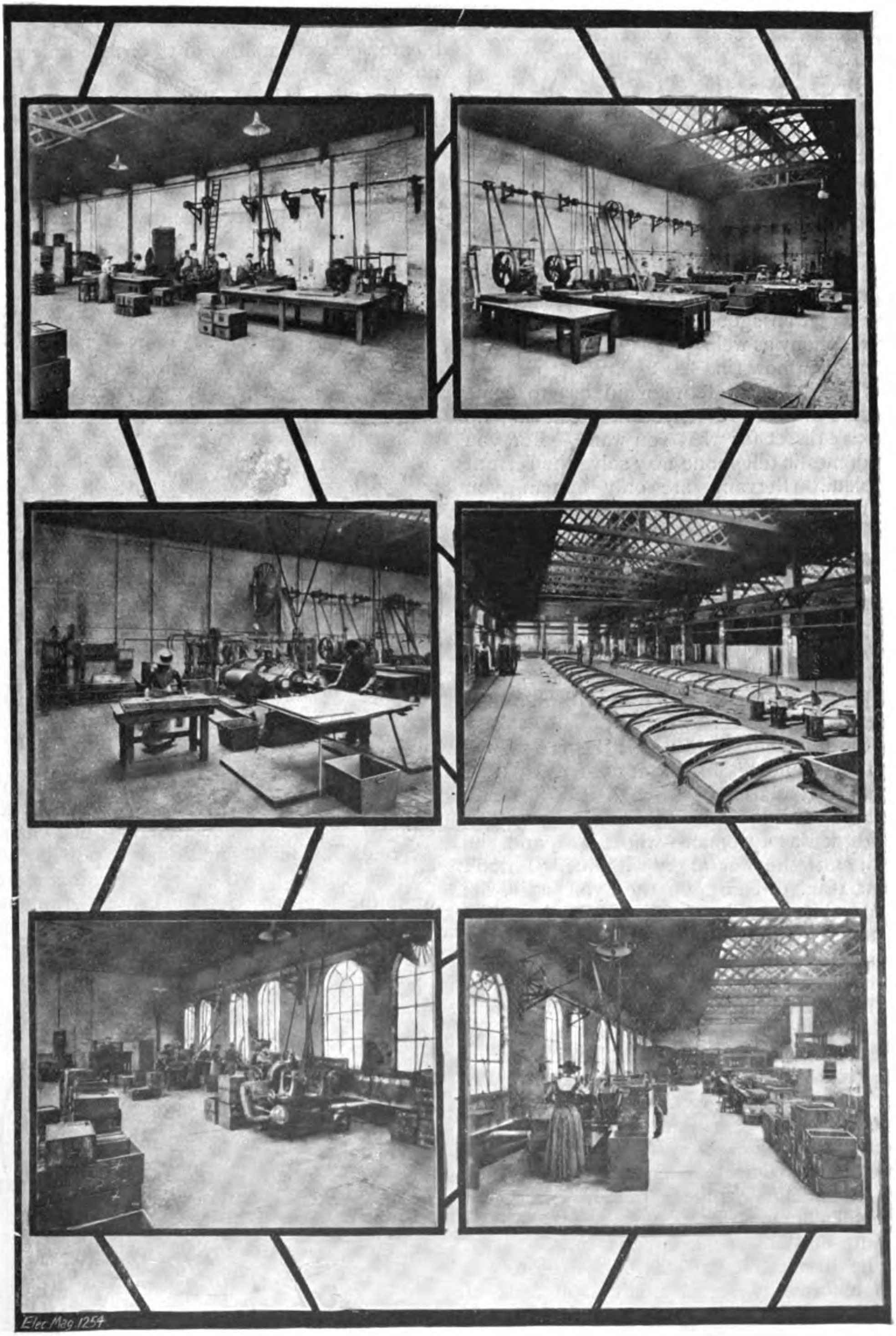
In twelve months something like thirty-five million feet of carbon rods are needed for all the British arc lamps. Think of it—over one hundred thousand miles! "Where does it all come from?" we hear you ask. We must answer this question by asking another: Where could it all come from? And to this we reply that there are carbon experts and a carbon factory in this country capable of meeting the home demand were they given the opportunity. At present they must be content with under one-third of the supply, but financial considerations do not allow matters to stand at that. As a business man, you know that your concern could not long remain idle for two-thirds of its output, and you would appreciate the situation still less if out of sheer cussedness your neighbour refused to support your trade.

Now we want to bring this argument right home to you. At Witton, in Birmingham, the General Electric Co., Ltd, established carbon works six years ago, because they felt it a matter of national danger that Britishers should rely entirely on the foreigner for their carbons. Remember, our Navy and Army use arc lamps—those great searchlights piercing the darkness in search of the enemy—and in war time, if the supply of carbons were cut off from outside, the fighting arm would be practically scotched at night. The works referred to employ over three hundred hands and produce a carbon rod superior to that procurable from the foreign manufacturer. They are equipped with the latest machinery, and everything is done for the comfort of employees. The views opposite show how commodious the premises are and give a good idea of their extent. But the company cannot keep their end up against foreign competition unless they are more generously supported by home carbon users. In three years they have wrested ten million feet from the outside maker, but they want the other twenty-five or best part of it.

What is to be done? What can you do? You can do your share by using "Witton" carbons in your arc lamps and by insisting that your dealer supplies no other. You want to be patriotic, don't you? Well, here's your chance.



A Striking Advertisement appealing to British Patriotism.



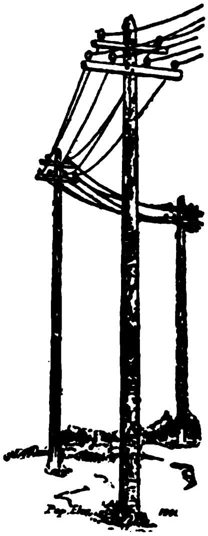
Views in the only Carbon Works of which Britain can boast. They are at Witton, Birmingham. See article opposite.

Telephone Calls.

An electric bell installation is good for telephony as well. Where you now ring up the kitchen and the maid has to come upstairs to take orders, you then can ring up and ask direct for what you want. For you the domestic telephone may solve the servant problem. Servants are only human, you know, and where one journey will answer for two, it will make all the difference between a temporary and a permanent situation. Just you give it a trial. If you've got electric bells, ask your electrician to fit up the telephone. He won't have to run any more wires.

The madam of the domicile took the telephone to answer a long harrowing ring. Putting the receiver to her ear, in a soft voice she said, "Well?" and "Yes, this is 27——" and then quickly dropped it as if a stroke of lightning had rushed through it. "Wasn't that mean?" she said. "I told that woman—yes, it was a woman—who I was, and she said, as if she was angry with me, 'I don't want you,' dwelling on the 'you' as if she could bite my head off if she had the chance." And the madam went about her work with a real sadness in her heart, because somebody had treated her very meanly. This is but one case of the scores that occur every day. It teaches that there is a lack of courtesy in the world, and a good deal of meanness in the place of it. But the incident gives a hint which should be heeded. There is no place where real courtesy can be so well shown as over a telephone. One may feel a sense of shame to be rude in another's presence, but with the telephone, all one can go by is his good nature and innate purpose to treat all kindly. If he hasn't this he may fall. Courtesy is not a formality; it is a virtue, a phase of religion, and a person only proclaims himself a heathen when he hides behind a telephone box to speak a harsh word to one who means no wrong.

Alexander III. of Russia is reported to have installed the telephone in his palaces in 1882. They were put in at St. Petersburg, Gatchino, Tsarsko-Selo, Peterhof and Livadia. At St. Petersburg the Winter Palace was connected up to all the theatres, because Alexander loved music and the opera. In the seclusion of his library he was able to enjoy the play without leaving his chair. At once the telephone became popular in Russian cities, and theatre connections were quite the fashion. Count Tolstoi was among those captivated, and took great delight in hearing opera music over the "'phone."



Long Distance Telephone Line.

Jones thought he was talking to Miss Chatquick, but it was his mother-in-law at the other end of the line.

Light and Power in the Country.

More and more it is the tendency to live in the country and work in the town. To the wealthy this means a large and commodious mansion, perhaps miles from a railway station, or anywhere. Country life, however, must be glossed with town comforts and the conveniences of the city. "In town, you know, we have electric light and boot cleaners, and all that sort of thing." Yes, and there is no need to deny yourself of any of them in the heart of rural England, or rural anywhere else for that matter. You can generate your own current on the premises and apply it domestically just as you are accustomed to when served by the cable outside your city door.

The modern oil engine is a sound, substantial article which costs very little both to buy and run, and which will drive a small dynamo needing even less attention. A stable or outhouse will accommodate the entire plant, and you will be troubled with neither noise nor smell.

For instance the old-fashioned ivy-covered vicarage depicted below is lighted throughout by the 3½h.p. oil-dynamo you see in the smaller adjoining illustration. It is easily started and will run constantly without attention—in fact, if you are in any way mechanically minded, and have the time, you may look after the little "power station" yourself. Forty 16c.p. lamps can be lighted by an engine of this kind for 2d. per hour, and almost in proportion as the lamps are reduced. Motors can be run from the dynamo or battery, and as far as the utilization of the electricity is concerned everything possible from a town's supply can be done with this type of installation.

Village lighting and power can be undertaken with oil engine plant, on a small capital outlay; and where local companies can be formed the concern will prove very successful. In several instances this has actually occurred and a return has been paid on the initial cost since the plant commenced to run.

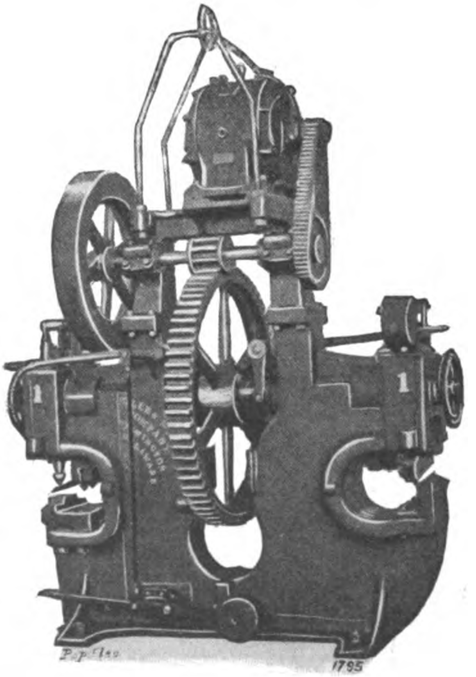
By the advances of engineering science you can see that country residents are now placed on a level with their town friends, whom at one time they were apt to envy, because of the supposed advantages of their position.

The Engine and Dynamo which is lighting up this old Country Vicarage.

(By courtesy of R. Hornsby and Sons, Ltd., Grantham.)

Portable Tools.

In our last issue we casually referred to the fact that at one time in the history of industrial effort the work was taken to the tool, but that an electric age reversed the process and carried the tool, irrespective of its weight, to the work. We illustrate this month a portable shears and punch weighing about a ton, which, by reason of the electro-motor driving it, can be slung from a crane and whisked to the spot where work must be done. The advantage of its portability is only felt in a broad long shop equipped with a good crane, but the chief feature turns upon its power agent—the handy, convenient little motor which is fed through flexible cables from the shop service and gets through its work just the same no matter where the tool is placed. Electric power is the essence of portability. You can have it "on tap" at different parts of the works, and when the motor-driven tool is moved up into position it can at once be set in motion by immediate connection to the mains.



A Portable Electric Shears and Punch, which can be conveniently moved to the most suitable working position.

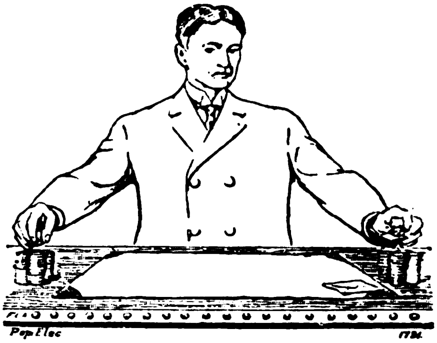


Figure it Out.

Why you cannot hang a gas engine from the ceiling to drive a fan same as that shown on page 39?

◆ ◆

What the inverted gas burner does for the fitting just above it, and what your lungs must be like if a piece of brass tube gets corroded in the way common to these latest imitations of electric lighting.

◆ ◆

What time it takes to install (i.) a motor and (ii.) a gas engine. The motor comes in at the window and the gas engine out at the door. This actually took place in a newspaper office a few weeks ago, and that gas engine hadn't a return ticket.

◆ ◆

What London would be like without its tubes, tunnels, tramways, and trains all operated by electric power.

◆ ◆

What a torpedo-boat destroyer would do without its searchlight, and whether gas would make up the deficiency.

◆ ◆

What the gas inspector will answer when you ask him what discount he allows for heating the chimney in your room from his fire. (Have a round at the punch ball and a cold bath before putting this question.)

◆ ◆

What it is connects your Manchester office with London or Paris, and helps you to get through your business quicker. (Think before you say, "Not a gas pipe.")

◆ ◆

How your business would suffer if the telegraph lines were owned by the gas interest. Anything electric, you know, must not be tolerated at any price.

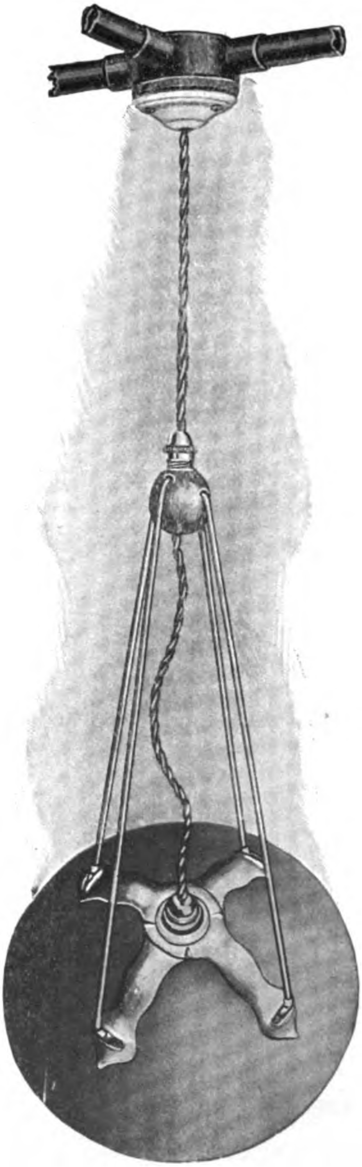
Things you ought to Have.

You may always turn to these pages for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

A Tilting Shade.

You know how awkward it is to set a lamp in just the position to give light without dazzling your eyes. A tilting shade will get you over this difficulty, as you will see from the illustration opposite. By its use you secure the maximum of convenience and control over the lamp above your desk. Drop a line to the Simplex Conduit Co., Ltd., Norfolk Street, Strand, W.C., for details.

Portable Electric Candle Bracket shown in use.



A Useful Tilting Shade for Pendant Electric Lamps.

* * *

A Convenient Fitting.

The illustration above depicts the use of a convenient wall fitting by which it is possible to place an electric candle bracket at various points of a room, by simply inserting in a special socket. The General Electric Co., Ltd., Queen Victoria Street, supply it.

A Light Tragedy

compiled by the General Electric Co., Ltd., Queen Victoria Street, E.C., and recently enacted in a London suburb. The moral of it all is that you should protect your interests in lighting matters by using only "Robertson" Electric Lamps, which, we are informed, for long life are unequalled. When you receive copies of the little book containing this diminutive "play" bear in mind that the moral is worth acting up to.

* * *

Don't burn your lamps after they have become blackened, as you get a poor light and pay for more current. It is cheaper to buy a new lamp.

Act I.

ROB.

Act II.

ROBERT.

Act III.

ROBERT'S ON.

PROFUSELY ILLUSTRATED. ONE PENNY.

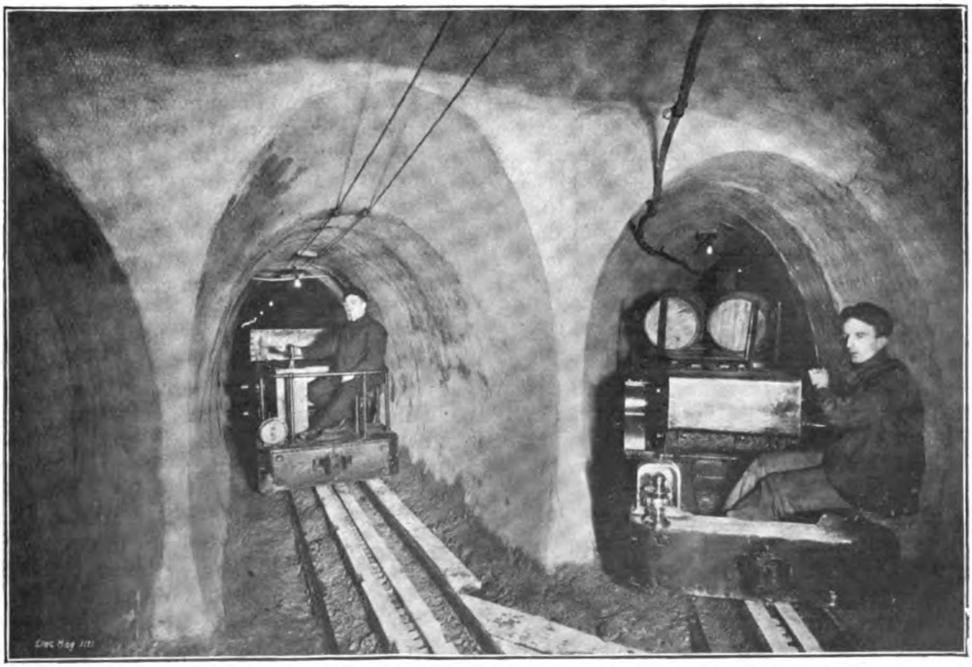
POPULAR ELECTRICITY

Underground Electric Express.

CONGESTION in the city streets. Traffic stopped. No chance of getting through for another hour. These are common enough incidents in the daily round of street traffic, but what delay and loss do they not inflict on commercial interests and the community in general?

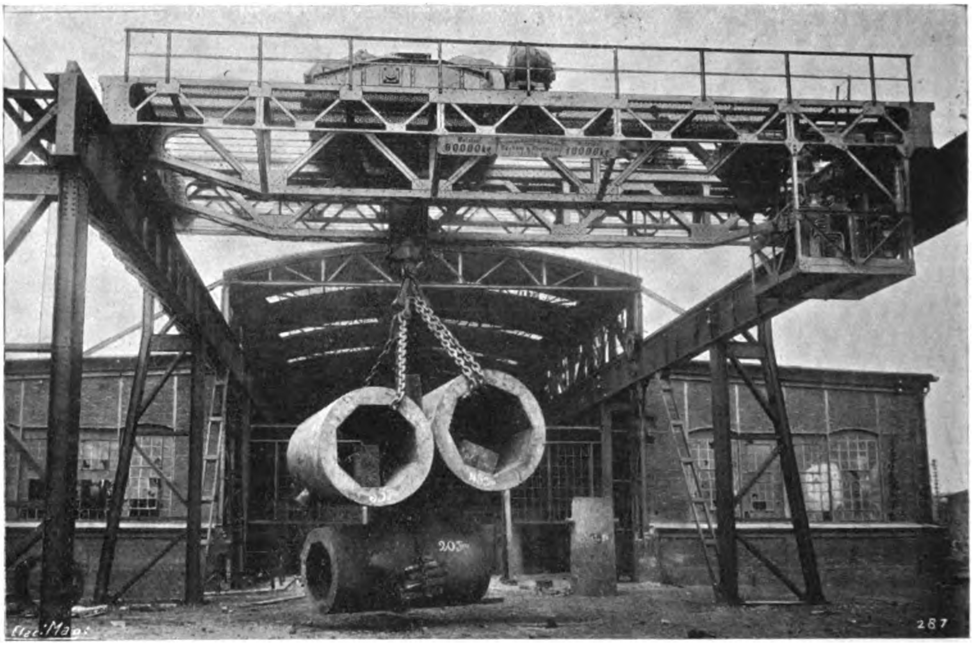
With electric power available, the safe and swift handling of passengers and goods over rails is at once possible. Slowly, but surely, the chief lines of our cities are relying on electricity to haul their trains, and new electric railways are springing up to give increased facilities to dwellers in town and country over those afforded by steam.

This is not all. The trains on the surface are supplemented by those running in artificial burrows beneath the soil, and these constitute one of the marvels of a marvellous age. The "Tuppenny Tube" is no longer a wonder, and travel through the bowels of the earth is treated as a matter of course. Now the example set by London is being followed by Chicago, where a service of freight trains is now running in shallow concrete tunnels, following the direction of the city streets above. The picture on this page shows how the locomotives converge from the tunnels on to a single track. The very notion of steam locomotives doing the same work makes one almost shudder!



Electric goods locomotives giving an express service under the Chicago streets.

A Powerful Electric Travelling Crane lifting a Heavy Load.



Heavy Duty Cranes.

OUR stability as a nation may be said to rest on our employment of the heavy electric crane. We turn out a warship, a locomotive, a bridge, and all our massive industrial machinery with greater economy and despatch for just one reason—our reliance on and prompt application of electric power for the moving of weights.

Without that invaluable addition to the industrial arm, not only would serious delays in the completion of important works ensue, but many of our recent engineering triumphs would have been quite impossible of accomplishment. Ship yard, machine shop, furnace, and foundry, each and all claim the services of electric traveller, crab, and winch, and to remove them would be to take away the vitals from the mechanical being to which they belong.

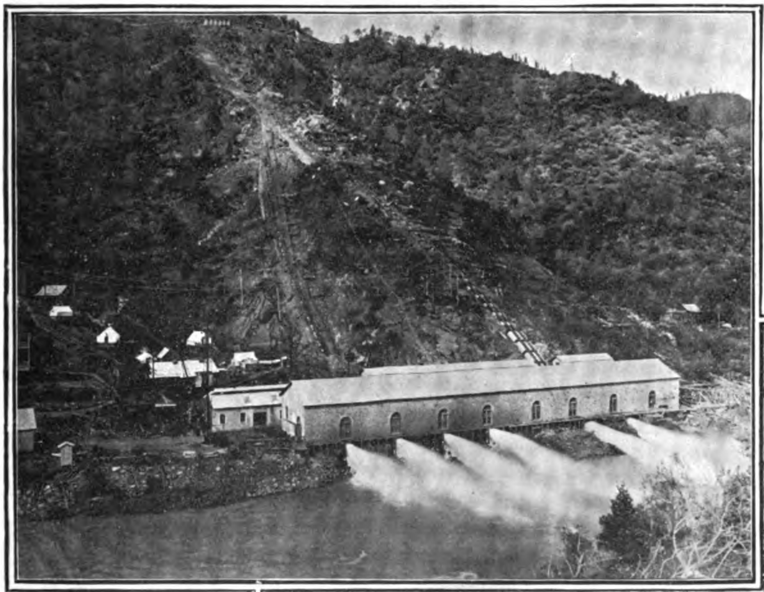
I know all this, we hear you say ! Exactly ; but we have an object, and do not merely delight in vain repetitions. We want you to apply this knowledge to your own case. You have got a hand winch in your timber yard, or a steam hoist over the roadway beneath your warehouse. Your shop is spanned by a noisy rope-driven crane, or maybe a gas engine drives the elevator to bring up your sacks of flour.

The utility of the mighty crane serving the builders of a cruiser or battleship is evident to you, and commands your applause —appeals in fact to your patriotism. Exactly ! Now you need look no further than your competitor's premises, where you see, mayhap, an electric gantry busily obedient to the man controlling it, and putting its owner days ahead of you in the delivery of rival goods. Not only can you admire *his* enterprise, but you can imitate it. You *must.* If you are to keep abreast of the forward movement of the times, you are simply bound to fit up your plant on modern lines.

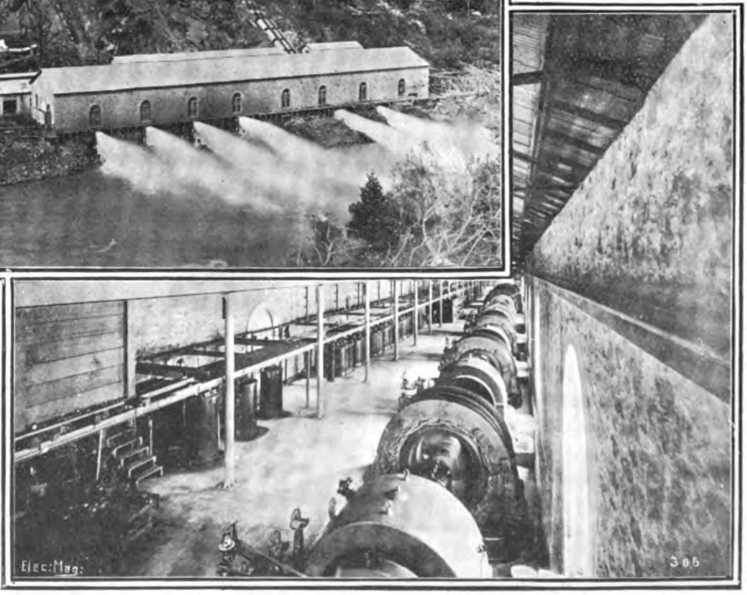
The heavy-duty electric crane may be able to serve you, but if not, and you want the lighter pattern, you can get it, and reap the undoubted benefit of its use. Your old crane can be converted and made to make amends for its dilatory ways while you get a higher duty from it and save time accordingly. When you have electric power available outside your works, it is, to say the least, unjust to allow the supply to remain untapped, and meantime your business is going downhill.

Hydro-Electricity.

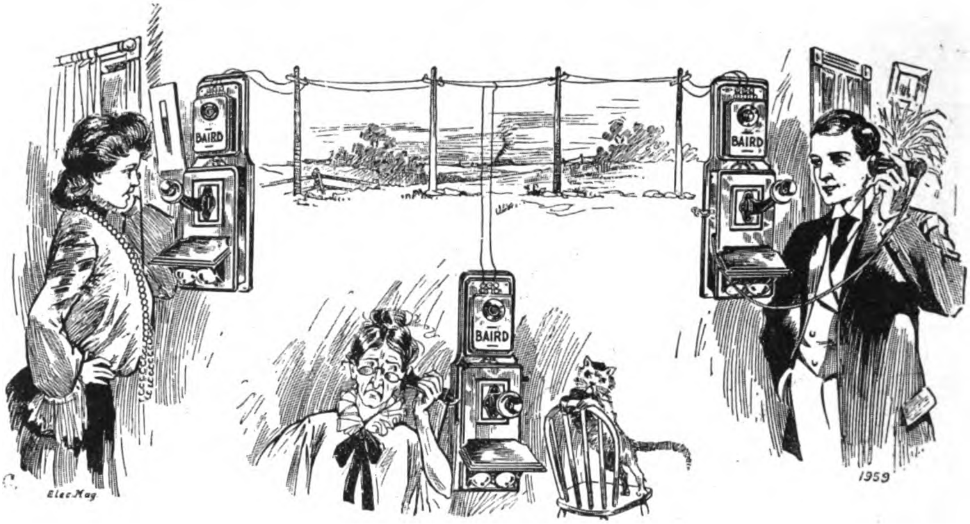
On the first page of our issue last month we gave a picture of a mountain lake and spoke of the energies its mass of water could exert if allowed to descend from a great height and drive a water wheel placed in its path. We can now give our readers some idea of how the force of falling water is turned to good account in an electric power house. The first of the two views below shows the outside of a station in California, and in the brushwood will be noticed the pipe lines conveying the water from its upper level to the wheels it is destined to turn. These pipes enter the building from behind and the water discharges into the river as will be seen at the front of the station. The lower view gives a glimpse of the water wheels and the dynamos connected to them, there being six in all of 800h.p., so this insignificant looking building shelters giants whose energies together nearly reach 5000h.-p. This power is sent "by wire" nearly 200 miles to San Francisco and is constantly available throughout the year. This may truly be termed a triumph of engineering and a striking testimony to the value of hydro-electricity or electric power produced by falling water. In England and places where there are few mountains, we have to do the same thing by burning coal under a boiler to raise steam, and thus obtain power.



Exterior of Power House and View of the Pipe Line down the Mountain Side, also the Water Wheels Discharging.



Interior of the Power House Illustrated above, Showing Water Turbines and Dynamos on the Right-hand Side.



A Typical Telephone Advertisement Depicting the Use of a Special "Party" Line System which does not allow a Third Person to hear the Conversation.

Over the Telephone.

Are you there, Exchange? What lives you dear telephone operators must lead. Fancy, they tell me the National Telephone company dealt with 1,053,000,000 messages last year, or 53,000,000 in excess of the year before. Number, please!

* *

In the summer of 1876 Prof. A. G. Bell heard over five miles of telegraph wire the first long-distance telephone message. It was from his uncle, who commenced by saying "to be or not to be," but it evidently was "to be," though he could not hear any reply, as the instruments were not coupled for reciprocating.

* *

Don't despise the telephone because it is a tiny affair and requires no attention. It is one of the greatest time savers of a busy age, and when judiciously used will save its cost in a short time. You only need to conduct a few simple but well-thought-out experiments and if properly carried out they will convince you of the value of the telephone to you. By experiments we mean trials of the instrument for business transactions.

Domestic telephony may sound luxurious and withal, to some, unnecessary, but its convenience is a thing to be experienced before it can be fully appreciated. If your house is fitted with electric bells, the very slightest modification of the pushes will convert the wiring into a complete telephone system, *without* a central exchange of course. The bells can be used just the same, but what a convenience to send a message immediately after your signal instead of waiting to deliver it in person. These tiny telephones are cheap, so are within the reach of all.

* *

Telephone manners are as essential to good breeding as the control exercised in personal conversation. Some people are mean enough to drop their manners when they pick up the receiver, and unfortunately they seldom meet the rebuke they deserve. If a practice were made of refusing a hearing to this class of telephone hog he might soon mend his ways, or, what would be better still, give up using the telephone altogether.

* *

If the use of the telephone continues at the same rate as it did last year, we may soon expect to see one in every middle-class household.

Smoke and Steam.

*T*HE national glories and industrial triumphs of Britain are enveloped in smoke and steam. We are great among the world's peoples, because of our coal and the uses to which we put it. This will be so while "Britannia rules the waves," for we are abundantly blessed with coal-fields and, what is equally important, the energy to work them.

But (yes, there's a but in it), in our haste to turn this good coal to useful purpose, we have positively wallowed in it (to stretch the application of a descriptive verb), brought it into our homes and workshops and made it do on the spot what we want of it. We need not show you murky factories and sooted buildings. You know of all these, if you are not already surrounded by them. We should like to tell you that they are quite unnecessary, and that a small effort on *your* part will contribute towards changing the aspect of affairs.

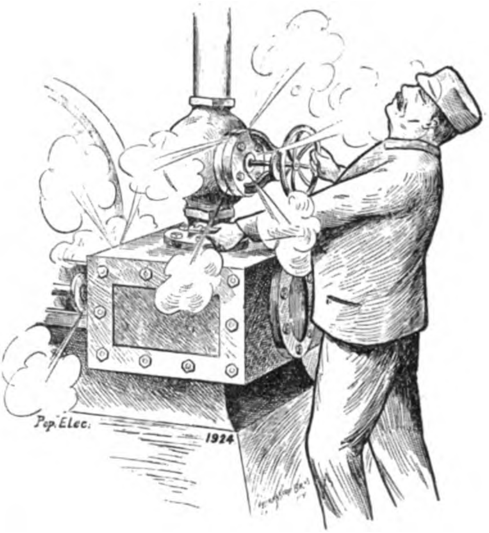
Smoke and steam are the elements of the power-house, and can be "cribbed" and "cabined" within the borders of the coal-field. At the pit's mouth they can be turned to account, and their latent energy used to generate electricity can in that form be transmitted to the towns many miles away.

Already this is being done in this tight little island of ours, but the coal is brought to the towns, where it is used in the local electricity works to feed boilers and raise steam for the power generators. Already by the greater employment of electric light and power the atmosphere of our great cities is being cleared, and we are gradually beginning to realise the benefit of the change.

Cut Your Smoke Off Short
Pop. Elec.
1924

This is the Moral of our Story.

This great problem has, however, its personal side, and this is where our argument appeals directly to *you*. The advent of the electric lamp and motor is a personal triumph *for you*, if you are among those who patronise them and encourage their use. Remember that by cutting *your* smoke off short you are adding to the comfort of your neighbours, setting a good example and *directly* assisting the coming of that city with cloudless sky and clean streets which we all hope is somewhere ahead of our efforts.



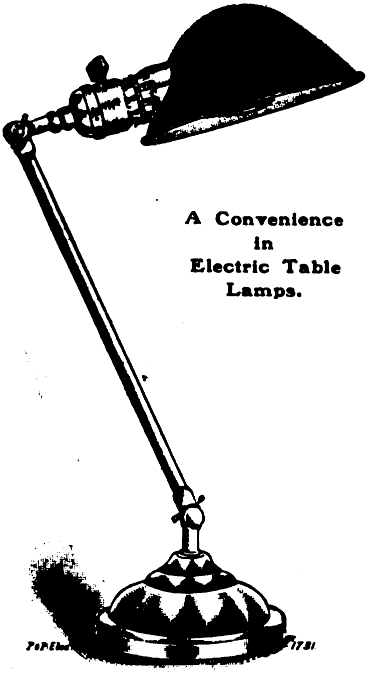
"Incidents" in the Handling of a Steam Engine.

You are the reformer to herald in this great revolution. 'Tis true your name will not go down to posterity, but at least you will have the satisfaction of knowing that you did your best and showed the way to the breaking down of a prejudice which would keep us chained to the methods of our forefathers.

Without this individual effort so great a reform can never come. Unless the individual is open to persuasion on this vital point, all the missionary work will be unavailing.

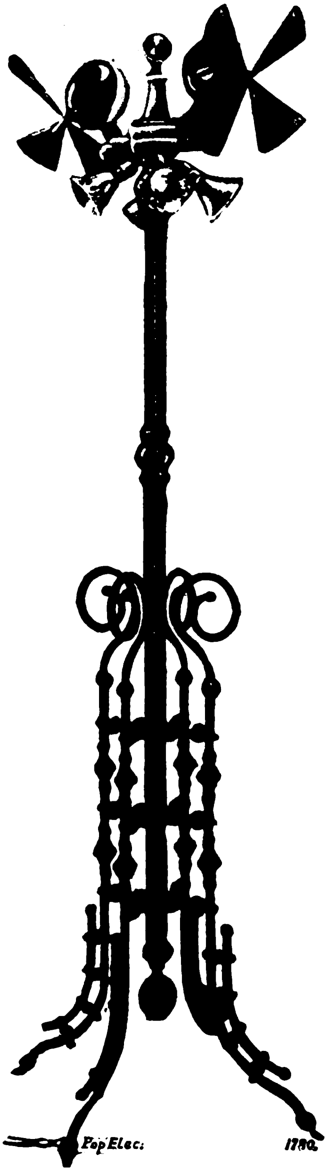
Concerning Convenience.

THE term civilisation is synonymous for convenience. For the sake of greater convenience man has become civilised; at least, that is the ultimate end and aim of his quittance of the ranks of barbarism. At present, convenience is largely dependent upon cost, or in other words, to further the alliterative tendency of our heading, convenience comes with cheapness.



A Convenience in Electric Table Lamps.

Electric light and power may be counted among the cheap conveniences of the day, but comparatively few have realised their claims upon the community. Any article designed and produced in the interest of convenience should receive due consideration, and the only conclusion possible with electricity is its complete command of the situation. Examine, for instance, the illustrations on this page. The table lamp is the very essence of compact convenience in the lighting of a desk. It can be placed in any position, and being light is easily moved from place to place. Again, look at the handsome stand, crowned with lamps and fans, diffusing soft light and giving gentle breezes to all around.



Electric Light and Power Conveniences par excellence.

These things are the acme of convenience, and are within your reach if you have an electricity supply available. Why not take the matter up with the local electrical engineer?

Electricity from Coal.

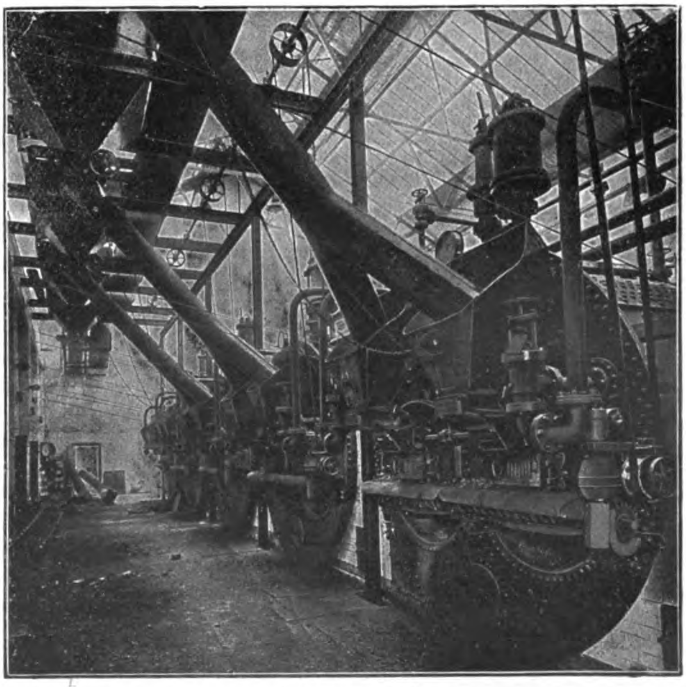
The hardworking servant of electric generating stations is the steam engine. Go into what electric light and power-station you may you will invariably find the boiler-house, and there, hard at work, the engine and the boiler. It is the steam that sets things going, the steam that keeps them going. To get up steam fuel is necessary, and the standard fuel in this country is coal. The immense quantities of coal used in the furnaces under the boilers for this purpose add greatly to the cost of manufacturing electricity, just as the necessary kitchen fire or gas at home adds to the cost of the dinner.

In all the works where electricity is generated one of the chief objects of the engineer is to generate it as cheaply as possible, and an expert engineer will begin by reducing his boiler-house costs. If he does this satisfactorily he is a long way on towards making cheap electricity. The cost of electric-current varies very much in different towns. In some it is as high as eightpence per unit and in others it is twopence or even less. It is almost certain that where the price of current is very high the coal costs and boiler-house expenses are much higher than they ought to be or than they would be if the engineer were a go-ahead man and managed his business thoroughly.

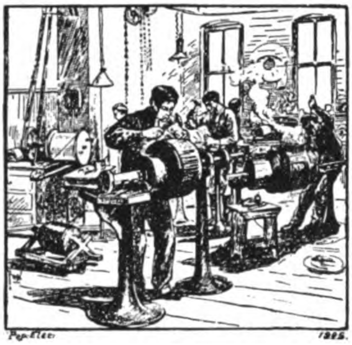
One effective way in which an engineer can reduce his boiler-house costs is by seeing to it that the coal is put into his furnace by machinery instead of by men.

It is a very extravagant way to employ an army of stokers to open the grate doors and shovel in coal. It is not only extravagant in the large wages bill that has to be paid, but it is also wasteful because the constant opening of the furnace doors admits cold air, which has a cooling effect on the temperature of the steam. Just as the incessant opening of the oven door in the kitchen retards the dinner, so the constant opening of the grate doors beneath the boilers retards the steam. But more than this, the inrush of cold air carries off quantities of unburnt fuel as smoke, all of which is sheer waste, and, in addition, frequently leads to fines for smoky chimneys.

With the machine-stokers used by up-to-date engineers in their boiler-houses, all these objections are overcome. Only one man is required to see to the stokers, and the furnace doors are not opened at all. Besides these points in favour of mechanical stokers, there is also another very important economic result to be considered. A very much cheaper class of fuel can be burnt in the furnaces, fuel which it is impossible to burn where men are the stokers instead of machines.



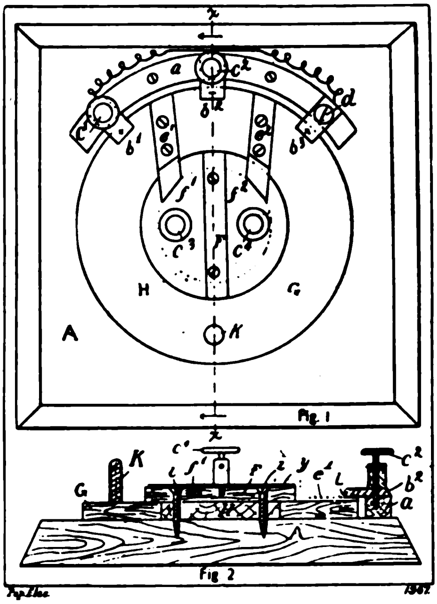
Boiler-house of a Modern Electricity Works.
(Illustrated by courtesy of Ed. Bennis & Co., Ltd.)



Something to Make.

Reversing Switch for Electrical Experiments.

A HOME-MADE reversing switch, suitable for use by students of electrical and engineering courses in performing experiments, is shown in the diagram. Referring to Fig. 1, A is a pine board 4 in. by 4 in. and a is a circular piece of wood about ¼in. square, with three brass strips, b^1, b^2, b^3, held down by two terminals, c^1, c^2, and a common screw, d. Post c^1 is connected to d by an insulated wire. About the centre piece, H, moves a disc, held down by another disc, F (Fig. 2), fastened through the centre piece to the wooden base, A, by wood screws. On the disc, G, are two brass strips, e^1 and e^2, so arranged that when handle K is turned to one side, their one end just slips under the strips b^1, b^2, or b^2, b^3 respectively, making contact with them, as shown in Fig. 2 at L, while their other ends slide in two half circular brass plates f^1 f^2, held down on disc F by two other terminals, c^3, c^4, making contact with them as shown at y, Fig. 2.



Plan and Section of Reversing Switch.

The action of the switch is shown in Fig. 1. Connect terminal c^1 to the carbon of a battery, and c^2 to the zinc. Then, if you turn handle K to the right, so that the strips e^1 and e^2 touch b^1 and b^2 respectively, terminal c^3 will show + and c^1 − electricity; vice versa, if you turn the handle to the left so that e^1 and e^2 touch b^2 and b^3 respectively, terminal c^3 will show − and c^4 + electricity —*Popular Mechanics.*

* * *

Reversing Small Battery Motor.

MAKE the switch from a piece of slate (for the base), two strips of brass, a rubber strip and handle, and some binding posts from old dry batteries. Fasten the brass strips at 5 and 6, Fig. 1, so they can swing from 1 and 3 to 2 and 4. Hold the brass strips apart by hard rubber strip and screws. Do not let the screws come all the way through the rubber strip. Screw a rubber handle on to the rubber strip to move the lever back and forth. Fig. 2 shows the arrangement of strips, handle, screws, etc., in detail. Fig. 3 is an end view of the same.—*Popular Mechanics.*

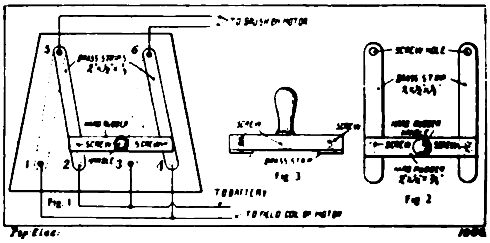


Diagram of Small Reversing Switch.

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THE MOST REMARKABLE, most useful, and most interesting periodical to-day dealing with electrical matters is The ELECTRICAL MAGAZINE. Each issue contains from 100 to 200 pages of valuable matter splendidly illustrated. It is a journal which every man interested in Electricity and its applications should take. A single copy will be sent by the publishers for 9d. in stamps, or it can be purchased for 6d. on the bookstalls, or ordered through your newsagent. Address: 4, Southampton Row, London, W.C.

Sparklets.

The education question is solved by POPULAR ELECTRICITY. You need not struggle through the clauses of Mr. Birrell's Bill. Read POPULAR ELECTRICITY instead.

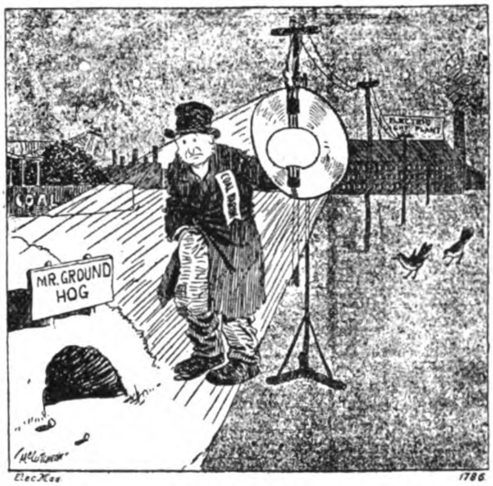
* *

Niagara is to be preserved. May we gather from this that there will be a corner in "tinned falls" before long?

Such catastrophes as the Courrières mine disaster will be quite impossible in a few decades. What! electric lamps in the mine? Not at all! Mines will be done away with! Coal as a power agent will be superseded by hydro-electricity.

* *

It is stated in America that if the ground hog sees the sun early in the year, there will be six weeks' cold. The sketch below, taken from an American contemporary, shows an artful "coal baron" trying to deceive that hog with an arc lamp. He wants to clear the coal pile behind him at a big profit!



Elec Mag 1786

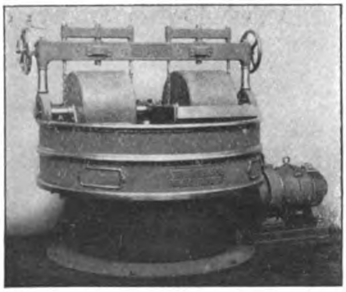
* *

Why are we not treated to "incidents" like the following from the *Daily Mail* to break the monotony of electric-car travel in this country? "An exciting scene occurred in Ashland Avenue, Chicago, early this morning, when six men stopped a crowded electric tramway-car and robbed the passengers at the point of the pistol, seizing what money and jewellery they could secure. The bandits fired through the windows, and beat those who resisted. The driver of the car fought desperately with the robbers on the front platform, and managed to turn off the lights, leaving the car in darkness. One of the passengers escaped and gave the alarm, and a squad of police arrived in a patrol wagon. They overpowered and captured the entire gang of thieves." Next, please, on the Electrified Underground!

ELECTRIC POWER IN THE SMALLER TRADES.

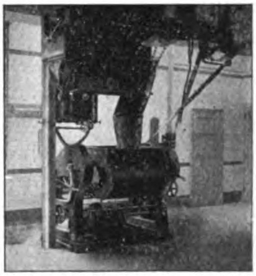
(Special Article.)

In the rush to-day to record the wonders of our time, a feverish desire seizes the chronicler to make history of man's achievement among the great and ponderous; to tell the tale of smaller deeds well and truly done is deemed a task unworthy the writer's effort and one bringing little or no satisfaction in its wake. We are none the less taught to believe that life is made up of little things whose insignificance has, however, a cumulative effect in contributing towards the formation of the mighty and wonderful, and about which we are too apt to rave.



Lundell Motor driving a Chocolate Grinding Machine.

In this article we want to draw attention to some of the details which make up what is broadly known as industrial electric power. You are accustomed to read in your morning paper (which, by the way, is hastened from a chaos of detail by electrical means) of an electric locomotive of so many thousand horse-power or of the revolution in manufacture made possible by some monster electric motor, or of a hundred and one "electric marvels." It is not often the *Morning Mirror* or the *Daily Leader* tell you that J. Pigbie is driving his sausage machine by the latest electric motor, or that W. Buntuk is delivering his loaves in a modern electric van. We want to supply this obvious deficiency by giving a few illustrations of and a running chat upon some of the "trady" applications of electric power, feeling that the interest of some at least of our readers will be aroused. We are enabled to do this through the kind assistance of J. H. Holmes & Co., electrical engineers, of Newcastle-upon-Tyne, who have had an exceptional experience in this field, and consequently were able to place matter and illustrations at our disposal.



A Dough-mixing Machine driven by a Lundell Motor.

At the outset we may diverge a little to make a few remarks on electricity and electric power. We cannot attempt to go closely into details, but, speaking generally, we may tell you that as a power agent the electro-motor is unique among mechanisms because of its lightness, portability, cleanliness, economy, and flexibility. A motor operated by electricity is ideal in constructive detail and practical in effective effort; that is, it *directly* performs the work required of it, without recourse to cranks, levers, pistons, valves, and flywheels. Engines driven by steam or gas perform innumerable mechanical contortions before the plain, straightforward rotary motion of the shaft is arrived at. If

Portable Electric Drills driven by small Electro-motors.

Exterior View of a Typical Electro-motor, illustrating its compact form and absence of complicated parts.

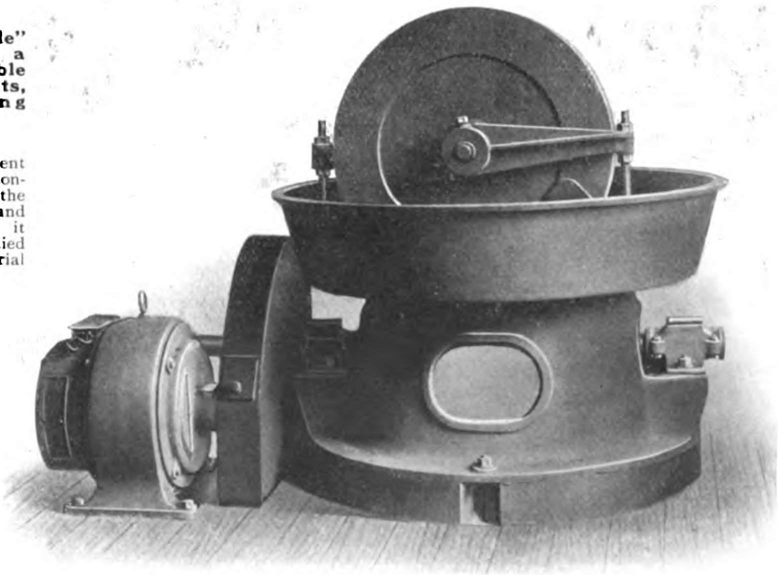
you run one or other of these you will understand what we mean. The electro-motor does away with all this. It gets down to simple rotary motion at the start and saves you a lot of space, a deal of noise, incessant worry, and a heap of money. This is no fairy tale. You must realise this when you examine the views dropped among these lines. They represent actual instances of electro-motors driving various useful machines now common to well-known trades. After due consideration of the results obtainable from driving machinery with steam and gas power and those promised, and frequently guaranteed, from the employment of electricity, the proprietors of the establishments in which the particular plants are installed decided upon a wholesale adoption of electric power as the only rational course open to them.

Now a word as to the supply of electricity, as we feel we have gained our point that the electro-motor is a desirable, nay, an essential, accessory to your business. In most towns there is an electricity station, and the underground cables which it supplies will doubtless pass your door. If this is the case you can readily arrange to have a power service at reasonable cost. We cannot give you figures, because prices vary all over the country, but the more current you take the less you will be required to pay for it.

If there are no electricity mains near your premises, and if your power demand is large enough, you can install a generating plant and furnish your motors with energy from it. This is not as costly as it at first looks, but you can confirm any doubts on the subject by taking the advice of an electrical engineer upon whose decision you may implicitly rely.

An Electro-motor dissected, showing the substantial construction and simplicity of parts.

As a general rule, however, we can safely state that the supply of electricity will be

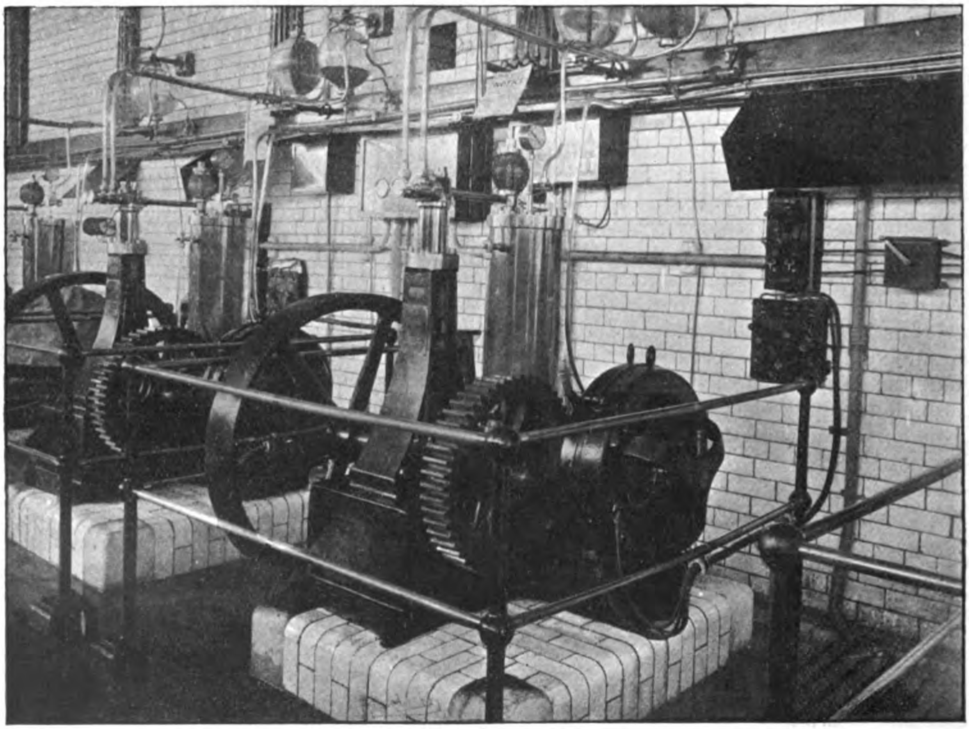


15 b.h.p. "Castle" Motor driving a Pan Mill, suitable for grinding paints, putty, printing inks, etc.

This is an excellent example of the convenient drive which the electro-motor gives, and of the small space it occupies when applied individually to industrial machines.

found ready to hand. Power plants are now springing up in all parts of the country, and before many months have elapsed electricity will be available in the chief towns and larger villages.

Now a word or two on the position of the electro-motor may be deemed relevant to the subject; by position we mean the particular spot it can occupy to do certain work. With a steam or gas engine, as you know, only one place can be found for either—that is on the level floor, whether the engine is vertical or horizontal. It is not common practice to bolt either one of them on the wall or the ceiling, and obvious restrictions prevent the accomplishment of this, however desirable it may seem. Again, steam and gas engines are not made small enough to connect individually to single machines such as mortar mills, dough mixers, lathes, drills, etc. Even if they were their efficiency would be so low that they could not possibly be tolerated. These brief references to the shortcomings of steam and gas permit us to throw into bolder relief the advantages of positions which come naturally to the electro-motor. There is no place in which it cannot run in any position chosen for it. At this moment motors are running horizontally and vertically, bolted to floors, walls, and ceilings, suspended by chains, or revolving with parts they drive.



Aerated Water Machines driven by Lundell Motors, installed in a Newcastle Brewery.

To the tradesman with a minimum of space at command this feature is most valuable, and, what is more, it represents an increased output from existing premises without extension of buildings.

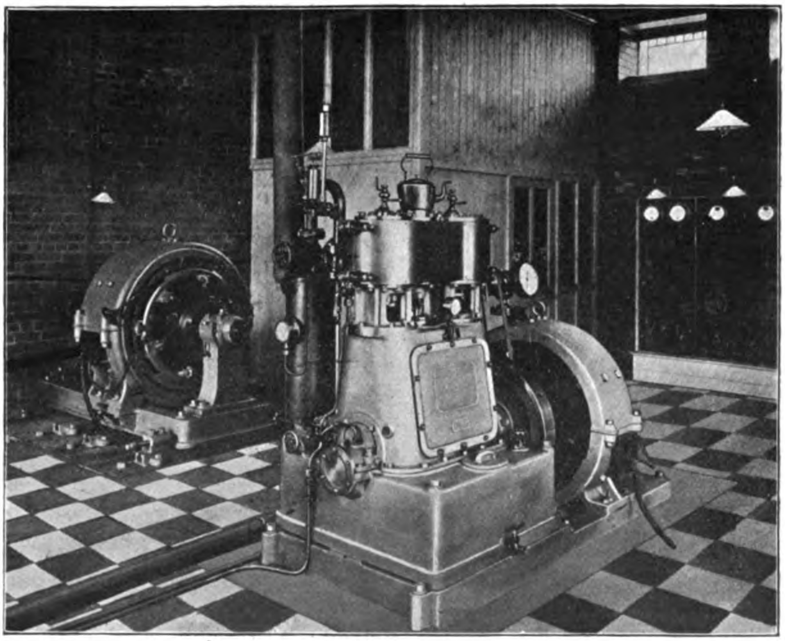
For instance, in a bakery equipped with modern labour-saving machines driven by steam engines, it is desired to install another dough mixer or extra plant, for which in the ordinary course additional buildings would be needed. By taking out the steam engine, space would be released for the machines required, if separate electro-motors were affixed to the plant already in use, or quite often a single motor will displace the steam engine and leave room for more machines.

This argument is equally applicable to other trades employing time and labour-saving appliances, and if borne in mind will bring home some remarkable economies to the mind of the proprietor. Assume for a moment that you walk through your establishment and imagine this machine or that operated by a separate motor on the wall here or the ceiling there, or under the floor somewhere else, you will astonish yourself with the extra work you could obtain from the buildings at your disposal. Again, there is the matter of driving the machines you have installed to increase the output and save labour. With steam and gas the power is transmitted by pulley and belt, and only when all the machines are running is the system working economically.

The electro-motor enables you to do away with all shafting losses or to reduce them considerably below that limit set by steam and gas. The fact that a single motor can be put in to drive each large machine does not entail the installation of a new machine. All the changes needed are in the method of driving and they are generally made at small cost.

We have said enough to at least indicate that in the smaller trades there are the strongest reasons why electric power should take the place of steam and gas. Having excited your interest, it remains for you to carefully weigh the arguments advanced and apply them to your particular case.

For the reasons given the time is now ripe for a full consideration of the operation of your machinery by the simple, speedy, and convenient motor as opposed to the noisy, clumsy, and wasteful steam or gas engine you may be using. Do not be put off with statements that electricity is the power of the future. Electric power is here now—waiting, maybe, outside your door, until you elect to take it into your service.



A type of small Steam Generating Plant which can be installed if electric power is not available, and Steam Boilers are already installed.

"Fanology."

No! not a new word in the dictionary, but a few words on keeping cool during the hot days. You can't do it with iced drinks; that's sheer liquefaction of your brass. Better put your money on an electric fan; it's so much more certain and satisfactory. The beauty of it is you don't need a gang of labourers and a steam crane to put it in. Your office boy can carry it upstairs, and if he's at all smart will have it in place and enjoy the first "puff" while you look on.

So don't put off getting one because you believe the eruption of Vesuvius will bring frost in June and skating on August Bank Holiday. When things begin to warm up you'll wish you had taken the tip, and when they get—well, decidedly hot, you'll find your order cannot be dealt with. The moral of our Fanologue is DO IT NOW. Doesn't our friend below here look as if he enjoyed it? You will, too.

Keeping cool by electricity. Only wants trying to be appreciated.

Figure it out.

Whether coal is as black as it's painted, and your heating bill is as long as it might not be in consequence?

◆ ◆

How far your front windows will travel when it's your turn to have a gas explosion? (This problem will lead you into the calculus and perhaps the asylum.)

◆ ◆

What extra you pay for chimneys and fire places when you are building a house instead of doing without them for the electric radiator?

◆ ◆

What weight of soot is deposited in London from smoky chimneys which might be done away with in an electric age?

◆ ◆

What the Japanese Navy would have done without its search lights, electric gun firing, wireless telegraph and field telephone? (Replies to be sent to the Czar of Russia by express letter.)

◆ ◆

How much gas can be generated from the water falls of the world and how long it would take it to reach the towns adjacent to them?

◆ ◆

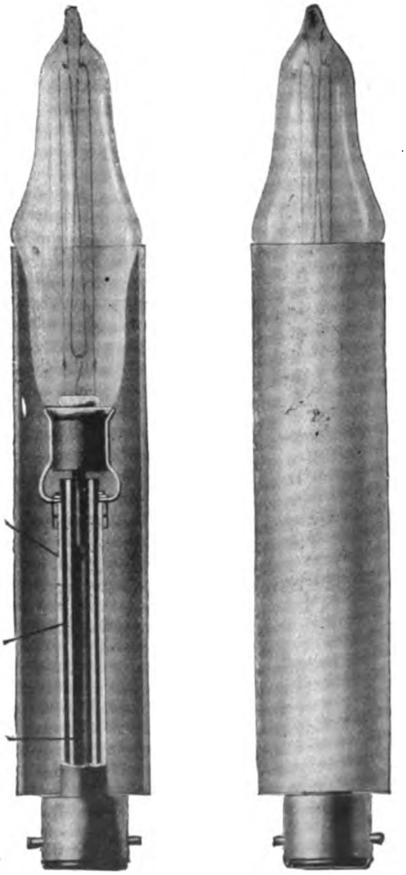
Whether gas is really worth all the trouble of improved burners, special fittings, and a trade of its own when it will ultimately give place to electricity? (You can do worse than ruminate on this.)

Things you ought to Have.

You may always turn to these pages for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

Electric Candles.

A feature of electric lighting is the candle lamp which gives an effect superior to the greasy, messy contrivance known as a candle for ages past. The resemblance to its spluttering namesake is very striking, as the illustration shows, but the similarity stops at the outline. It does not extend to the performance. When the electric candle has done its work it goes out without unpleasant accompaniments of smoke and smell. Flop! and it is out and you must then put in a new lamp. But when in use it gives effects quite beyond the best efforts of its one-time rival. You try a pair on the piano this summer and prove that "electrified" candles are all we claim for them. They are not expensive, and the General Electric Co., Ltd., of Queen Victoria Street, stock them.



◆

A Handy Motor.

In the selection of an electro-motor for direct currents it is well to be guided in a great measure by the name of the machine. The term "Lundell" is synonymous with soundness and efficiency in d.c. motor design, consequently you have merely to use that term when giving an order. If the details of this now famous machine are unknown to you, write to J. H. Holmes & Co., Portland Road, Newcastle-on-Tyne. They will send you a fully descriptive booklet. (An article dealing with their motor applications is published in this issue.)

Lundell Electric Motor.

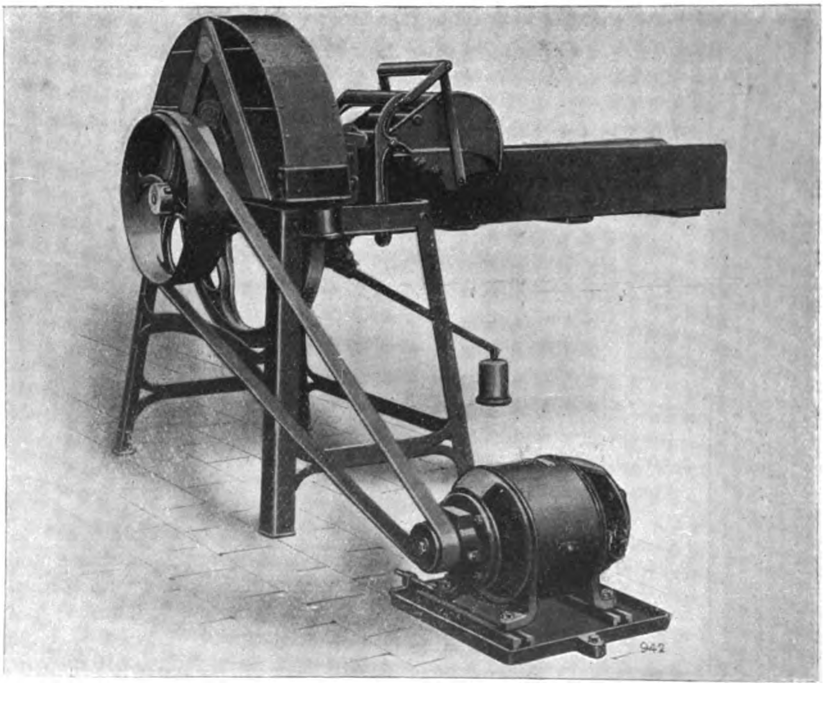
◆

Electric Signs.

The summer evenings are as suitable to the display of the electric sign as the dark nights of winter. There are more people about, and the chances of your sign attracting attention are greater. You can do more with an electric sign than any other sign, and now is the time to try one.

Electric Chaff-cutter.

The machine illustrated on this page will be familiar to our agricultural readers, and the fact that it can be driven by electricity may come as a surprise to them. It will be noticed that no alteration to the existing machine is needed, except the substitution of the hand-wheel for a power pulley. The motor is placed on the floor and belted to the machine. It may be arranged to run automatically and stop and ring a bell when the supply of fodder to be treated has run out. This introduces a valuable automatic element, which will tend to reduce the cost of labour without reducing the capacity of the machine. Where chaff-cutting is undertaken as a business, this feature has a bearing on the finances of the concern. The motor is, of course, the essential feature, and all details regarding it can be obtained of Crompton & Co., Ltd., Salisbury House, London Wall, E.C.



Crompton Motor Driving Chaff-cutting Machine.

Selecting a Motor.

The choice of an electro-motor should be undertaken with some care. It is not a matter for haste nor extreme deliberation. When called upon to decide with little or no knowledge of the "points" of a machine it is always well to take the advice of an expert.

Never be influenced entirely by price. This applies particularly to a second-hand machine, which may be represented as of a certain capacity, but which, on the assumed load, would probably burn out.

There are many reputable makers of electro-motors in this country whose standard lines can be depended upon, and if any readers of Popular Electricity require advice on the choice of a particular machine for a particular class of work we shall be pleased to help them with all the information possible.

PROFUSELY ILLUSTRATED. ONE PENNY.

POPULAR ELECTRICITY

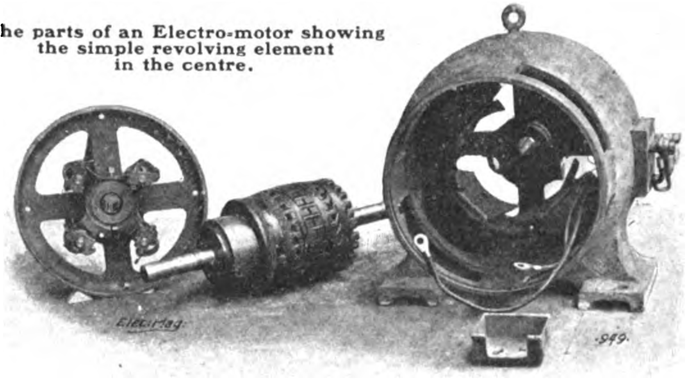
Electric Fairy Palaces.

We all read with delight, as children, the wonder stories of fairies and their mystic palaces, wishing that as we read the weird dream tales might come true. But is not this electric age of ours a realization of those travels through fairyland? Surely the Goddess Electra is more potent in magic-working than those charming fairies who have done nothing but fire our imagination and leave us disappointed!

Exhibitions are now our fairyland. Their stately palaces spring up mushroom-like in our midst and the varied halls of delight invite our entrance with charm and grace of exterior adornment, or hold us so spellbound that we lose desire to enter. Ever since exhibitions and "expositions" came into being on a large scale, the fairy Electra has whirled them to the heights of popular favour. Without her they could not be. Their attractions by day are as nought beside the spell they cast at night—for under cover of the darkness the fairy Electra displays her power.

Fired as we are with the enthusiasm of great exhibitions, we have the reverse side of the picture to examine, when the fairies are asleep or away on pressing business. After all, we must supply the material which the fairies transform with their touch into the wonderful, the charming, the unique. At once, then, are we pledged to confess that in our display of majestic palaces, wood, plaster, and iron fill a prominent place. They are our principal properties and, like all stage flimsies, are highly inflammable. But 'tis here the fairy Electra steps in. "My wonders," she says, "will give you all the delight, the mystery, without fear of fire demon or smoke cloud. My magic is not bought at the risk of life and limb, nor will it scorch the frail materials which give it expression."

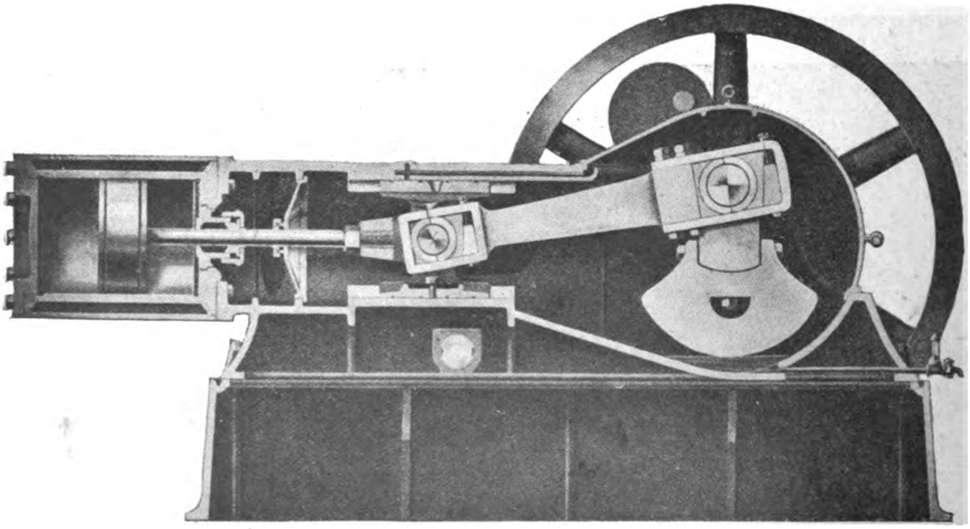
The Beauties of Electric Illumination. An Exhibition Palace brilliantly lighted at night.



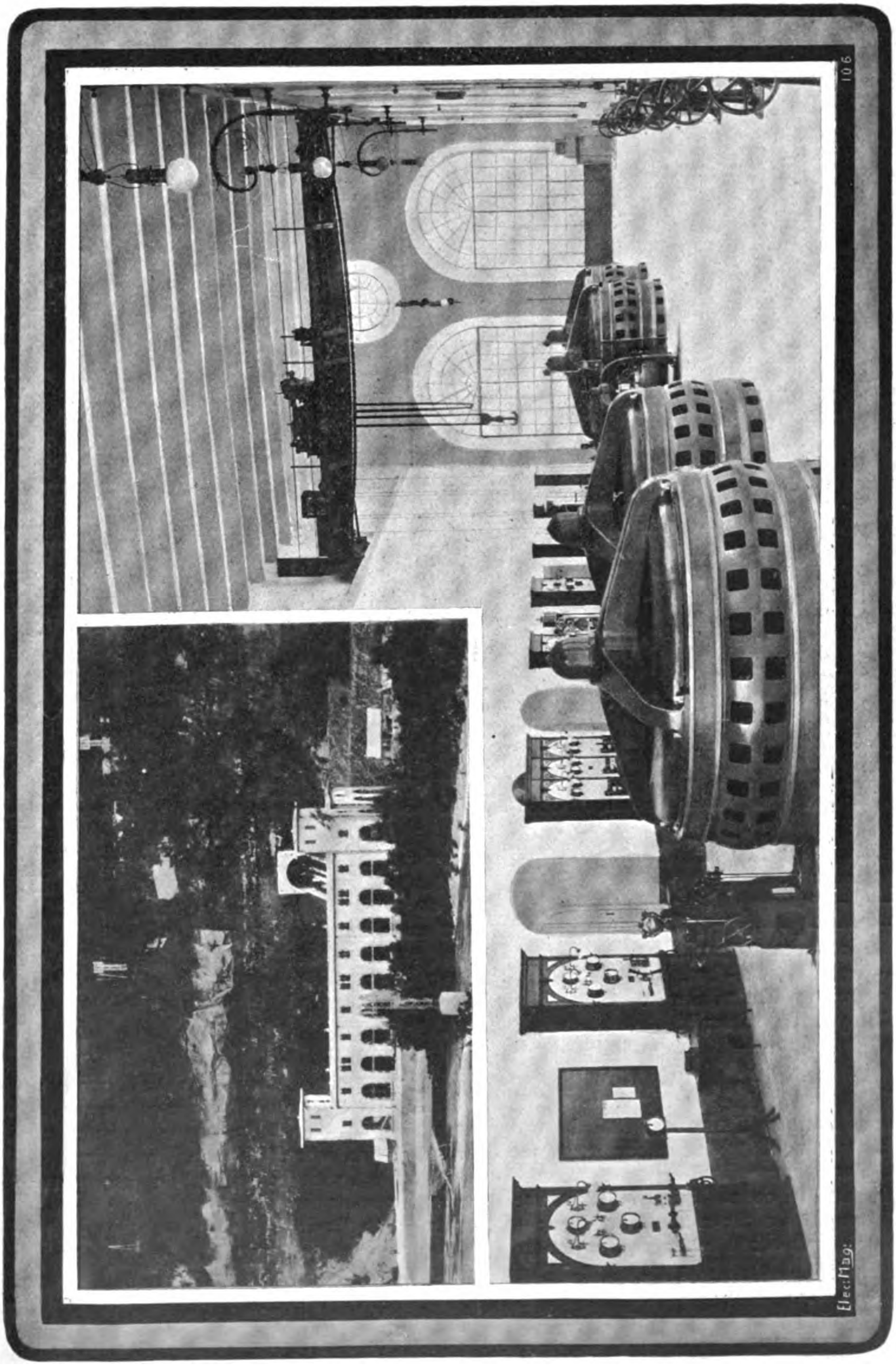
The parts of an Electro-motor showing the simple revolving element in the centre.

A Question of Parts.

Euclid said a point is that which has no parts and no magnitude. Not strictly correct as to the latter half of the analysis, but near enough for Euclid probably. We cannot apply the wording of the diagnosis strictly to the electro-motor, but, as in Euclid's case, some such statement would be near the mark. The members of the electro-motor cannot, however, be accurately decribed as "multitudes which none can number," even by the most enthusiastic statistician with an habitual leaning to the exaggerated side of figurative expression. To adequately convey an idea of the "components" of the electro-motor, a pictorial comparison must be called into view. We present it in the two illustrations on this page. The upper one depicts an electro-motor "dissembled," and the lower a section through a modern steam engine showing cylinder, piston and rods, slide block, connecting-rod, crank, axle, and fly-wheel. As a business question, we would ask which of the two would you select to do the power-work you have in mind? The motor simply "motes," that is, it does at once what you want it to do—it spins round. The engine must hesitate a bit, then it pushes out its piston, and then pulls it back laboriously, turning round the crank and heavy fly-wheel before it gives you the same kind of thing—rotary motion.



Section through a Steam Engine showing the many parts needed in its construction.



Views of a Modern Electric Water-power Station on the slopes of the Alps, illustrating how the natural waters of mountainous districts are turned to useful purpose.

Telephone Chat.

Our remark last month on telephone manners has raised visions in the mind of a writer to the *Daily Chronicle*, who sends in the following, which is entitled "A Lesson in Courtesy."

"Are you there?"

"Yes. Stop."

"What's the matter?"

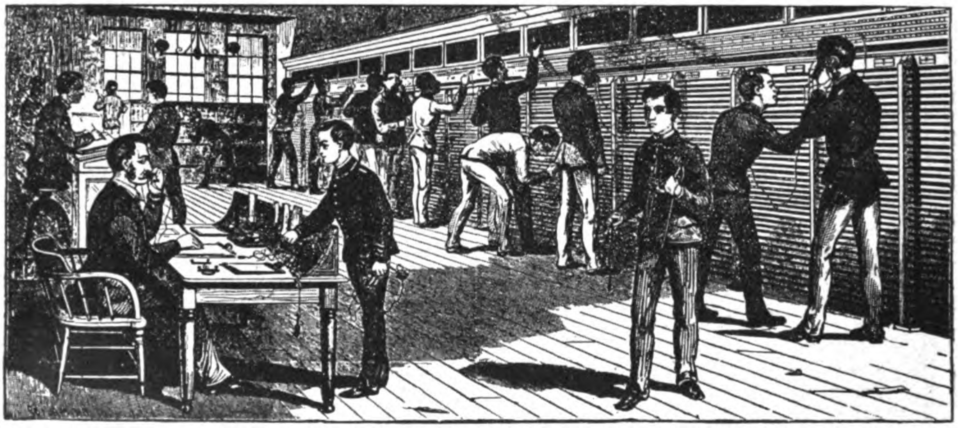
"Be very careful what you say."

"Don't understand. Want to know whether——"

"Steady."

"What?"

"No offensive language, confound you!"



What an early Telephone Exchange looked like. Where are the charming lady operators?

"What d'you mean? I'm asking you——"

"Say 'please,' you underbred, fifth-rate——"

"——, ——, ——."

"——, ——, ——."

"Had intended to invite you to dinner. —— —you—" (buzz—buzz).

"Mind who you're talking to—conf—oh! eh? Did you say dinner?"

"No. Go to——" (fizz—buzz—ting—ting). H. W.

* * *

There is nothing like taking time by the forelock, or, to adapt the saying to times present, always grasp the telephone receiver promptly (and of course firmly), as instance the following taken from the *Standard*:— "News has just come to hand of a timely rescue off the Isle of Wight. From his residence at Wootton Admiral Baird saw that a boat had capsized, and that three persons were clinging for dear life to the upturned keel. He telephoned to the coastguard station, and the coastguards launched a boat, and, after rowing hard for a mile, they reached the capsized craft, which was drifting out to sea. They rescued the three persons, provided them with dry clothing, and sent them home to Ryde." Admiral Baird must have felt gratified in watching the result of his promptitude.

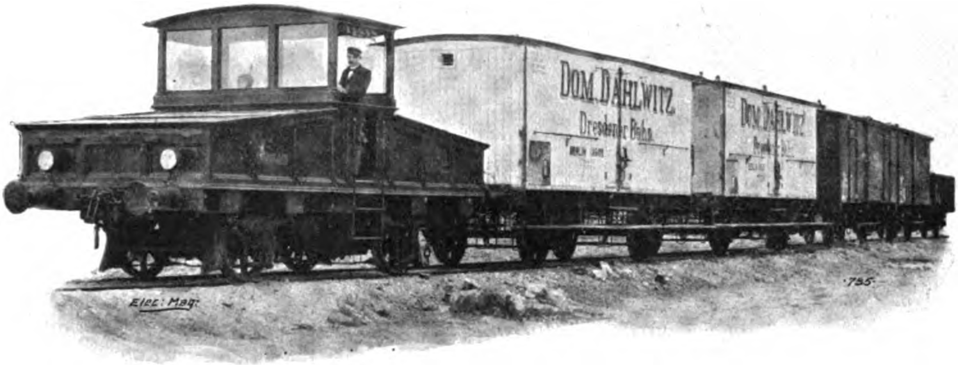
* * *

"Times change," &c., and so do telephone exchanges. The illustration on this page shows the interior of an old-fashioned American telephone exchange when telephones were in the bud, so to speak. There are no ladies, it will be noticed, and the gentlemen in attendance are evidently first-class contortionists, as they seem to have plenty of bending to do. The room is, curiously enough, lighted by gas.

* * *

If "telephone sight" were possible shopping methods would be revolutionized. Imagine a high-class drapery establishment conducting sales by "televue" in a department alive with gesticulating assistants waving dress-stuffs before a line of instruments while "milady" sits in her boudoir and makes her purchase at leisure. The shop-walker would be promoted to exchange manager as a matter of course.

An Electric Accumulator Locomotive pulling a Train of Waggons.



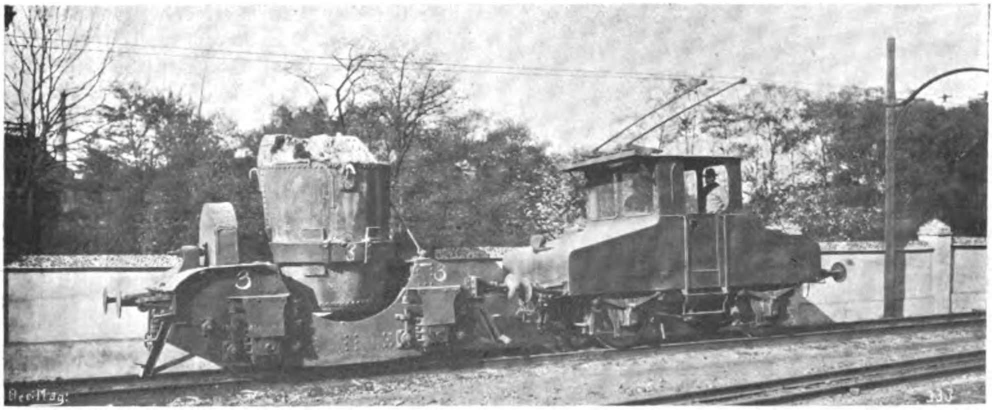
Electric Locomotives and their Work.

We have not yet got electric locomotives hauling our main-line trains—they will come in time—but they are widely used in the industrial world, and with great effect. On this page are illustrations of two forms of industrial locomotives. The upper one depicts what is known as an accumulator locomotive, hauling a load of waggons about the yard of an extensive works. The batteries are carried "fore and aft" of the truck, and will furnish electricity for about a day's working under normal conditions. With this arrangement the locomotive needs no overhead wires, and can travel anywhere over the tracks laid down.

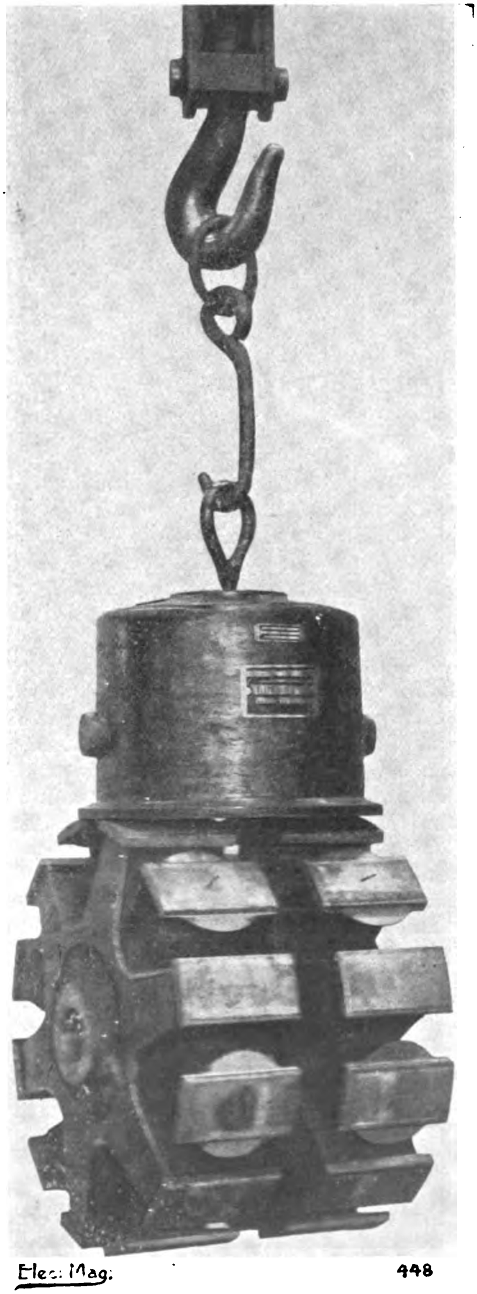
The other picture shows a trolley locomotive operating after the manner of the electric trams now familiar to our main streets. It is depicted hauling a heavy car loaded with a ladle containing molten steel which is being run from the furnaces into the steel foundry of a large works. To protect the driver from the heat the locomotive is fitted with special windows, and arrangements are made for tilting the ladle from the locomotive cab.

The two pictures are a striking illustration of the adaptability of electric power to industrial purposes. In the one case it is stored up and carried by the locomotive for use as required, and in the other it is furnished by a slender wire overhead from which it is taken by two trolley wheels.

This same remarkable flexibility of power is also available for other industrial purposes than traction, and in the pages of this issue examples of these will be found which will bear very close examination.



An Electric Trolley Locomotive hauling a Ladle Car loaded with Molten Steel.



A Typical Lifting Electro-Magnet raising a heavy weight of nearly two tons without tackle or hooks of any kind. The Magnet only releases the weight when Current is turned off.

Lifting Magnets.

The tale of how Baron Munchausen took himself by the hair and raised himself and horse from a morass into which both had sunk will not now find credence among self-respecting individuals, so we do not propose to insert it in detail. We thus briefly mention it because it serves fittingly to introduce a word or two on lifting generally. The mighty triumphs of man's constructive ability would be impossible were he without means of lifting weights—and heavy weights at that. The humble hydraulic jack and the pillar crane scraping the sky above the foundations of a tall building are alike a necessity. Materials like bricks, stone, timber, mortar and concrete must all be lifted by rope, chain and hook, and much time is wasted in fixing the tackle preliminary to the giving of the "right-away" signal.

With iron and steel, however, things are different. They are magnetic, and can be made to adhere under magnetic influence. Electricity can supply that influence quickly and with regular strength; it can as readily withdraw it—and all with a simple contrivance known as the electromagnet. Suspended from a hook and supplied with electricity, such a magnet, if held over pieces of iron or steel, will attract them and permit of their being raised to any height and moved any distance.

In the industrial world this is taken advantage of. Large steel and iron works are now fitted with "lifting magnets" which will raise bodies up to a given weight from any position. Scrap iron or steel for instance can be lifted from a heap without need for hooks, chains or tackle. It need not even be tied in bundles. Massive weights like that depicted opposite can be at once picked up, and while the magnet remains excited will be firmly held. When the current is switched off, with the weight on the ground of course, the magnet releases its hold at once. Two magnets on different hooks can also lift up long plates of iron and steel without any tackle being required. In stock yards valuable time is saved by the employment of these handy devices, and they can also be obtained for small shops and works.

A Considerable Item.

THERE is the man who uses electricity for light in his home, for power in his place of business, and who doesn't have to economize on anything in his personal establishment, but who, nevertheless, holds up his hands in holy horror at the thought of the "expense" of electric cooking!

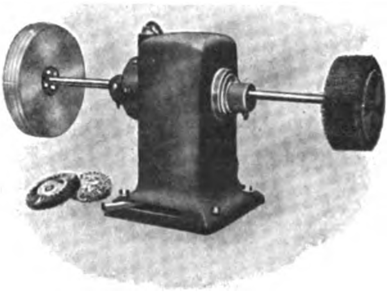
In some cases this is because he hasn't enquired into the matter, and therefore doesn't know that the company is willing to put in a separate meter, and charge only power rates for current used on a "heating circuit," and that the cost of electric cooking for a household is far less than is generally supposed. In other cases it is merely because the idea seems new. It hasn't yet had a chance to fit itself in among the familiar things — the commonplaces — of every-day life. Time will soon remedy that. But a majority, perhaps, pass snap judgment on the matter, as if it were something to be dealt lightly with.

It appears to us that there are many considerations conducive to the use of electricity for cooking, aside from those of expense. Among these are simplicity, cleanliness, avoidance of much of the mixed odour arising with older methods, freedom from leaking ranges which are not merely unhygienic, but positively dangerous, and particularly the improved flavour of viands electrically cooked, which, we are informed by an excellent authority, taste exactly like the epicurean cooking of still older days, done with pure charcoal heat.—*Electric City.*

A Word on Buffing.

It's curious, but some words robbed of a letter become really useful and stand for a good thing. For instance, "bluffing"—a something we all experience or make others experience in a lifetime—if deprived of its second letter is at once a transformed character. Buffing is quite another matter, as many tradesmen know. Not that they are innocent of acting up to the full terms of the word under discussion, but they certainly appreciate the merits of the verb "to buff." Watchmakers, silversmiths, and jewellers, for example, must buff (and bluff) their goods to do good business, and obviously the quicker they can do the thing the better.

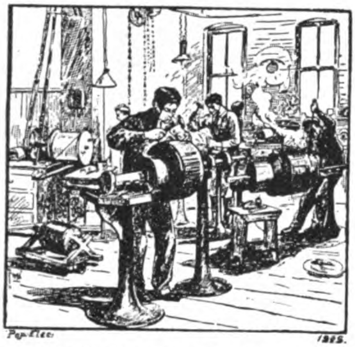
Electricity is what they want in the shape of a motor polishing machine, such as is illustrated on this page, and a handy article they will find it in practice. The motor develops ¼-horse power at 1000 revolutions per minute, or another size will give 2000 revolutions and furnish ½-horse power. It costs about a ¼d. an hour to run where electricity is sold at 2d. per unit for power purposes. If you are interested turn to page 79.



An Electric Buffing Machine which costs ¼d. an Hour to run.
(Illustration by courtesy of Electromotors, Ltd.)

A Word on Indecision.

When you are thinking of using electric light and power for the first time you may probably have the gas man worrying you with arguments in support of gas light and gas power. We do not say pay no heed to these. On the contrary we want them considered on their merits. What you must be careful of is the manner in which efforts are made to get your support of gas. Your mind is specially focussed on the advantages, but you have to *specially* weigh the disadvantages.

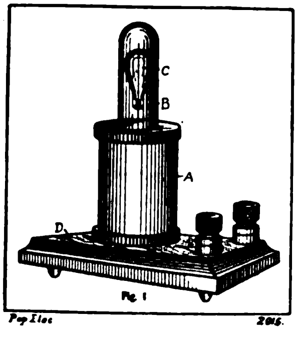


Something to Make.

How to Make a Galvanoscope.

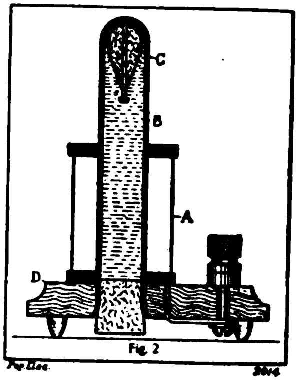
A GALVANOSCOPE for detecting small currents of electricity can be made from a coil of wire, A; a glass tube, B, full of water; a core, C; and a base, D, with binding posts as shown. The core C, which is made of iron and cork, is a trifle lighter than the water it displaces, and will therefore remain in the top of the tube normally; but as soon as a current of electricity passes through the coil the core is drawn down out of sight. The current required is very small, as the core is so nearly balanced that the least attraction will cause it to sink.

The glass tube may be a test tube as shown in Fig. 2, or an empty developer tube. If one has neither a test tube nor developer tube, an empty pill bottle may be used. The washers at the ends of the coil can be made of fibre, hard rubber, or wood; or can be taken from an old magnet. The base may be made of wood or any other insulating material, and should have four short legs on the bottom. Make the coil of single covered wire about No. 18 and connect ends to binding posts as shown in Fig. 2.



View of Completed Galvanoscope.

The core is made by pushing a small nail through a piece of cork. It should be made so that it will rise slowly when placed under water. Some filing may be necessary to get the weight just right, but it should be remembered that the buoyancy of the core can be adjusted, after the parts are assembled, by pressing the cork in the bottom of the test tube. This causes compression in the water space and specially of the upper cork, reducing its displacement and causing it to sink. The lower cork is then slowly withdrawn, by twisting, until the core slowly rises. The instrument will then be adjusted ready for use.



Section through Galvanoscope showing all the parts.

Connect the binding posts to a single cell of battery—any kind will do as a slight current will answer. On completing the circuit the core will descend; or put in a switch or push button on one of the battery wires. If the button be concealed where the operator can reach it, the core will obey his command to rise or fall, according to his control of the current. This is a mysterious looking instrument, the core being moved without visible connection to any other part.—*Popular Mechanics.*

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THE MOST REMARKABLE, most useful, and most interesting periodical to-day dealing with electrical matters is The ELECTRICAL MAGAZINE. Each issue contains from 100 to 200 pages of valuable matter splendidly illustrated. It is a journal which every man interested in Electricity and its applications should take. A single copy will be sent by the publishers for 9d. in stamps, or it can be purchased for 6d. on the bookstalls, or ordered through your newsagent. Address: 4, Southampton Row, London, W.C.

Sparklets.

In the dim future. "Are you the exchange?" "Yes." "Just ask your manager to take an order for a telephone, between my office here and my house in Derbyshire." "What rate?" "Oh! unlimited service—a shilling a week." "Certainly, Sir. It can be fixed inside two days. He will 'phone instructions at once."

Curious, isn't it, but very true. Electricity evades man while it lures him on to further experiment. He knows what it will do, but he does not know what it is or whence it comes. He can harness it to do his work, yet he can neither see nor touch it. The force, whatever it is, is as illusive and intangible as the will-o'-the-wisp.—*Bulletin*, New York Edison Co.

"The Man with the Millstone." A pitiable object upon which electric-power users gaze, as typifying the use of the fly-wheel instead of the simple motor.

Readers will do well to commit the following lines from the *Tyneside Electrical Pioneer* to memory:—

I dew believe that suction gas is the appinted ajint
Tew waft men tew the pearly gates and other parts adjacint.
I guess a bust-up cylinder's the quickest path ter Glory.
(The slight discomfort and the mess is quite another story.)
I dew believe that no one else can ever equal me
In cuttin' down initial costs an' runnin' guarantee.
Thet is, ez long ez what I say is not rejuced ter writin'.
(It's alwiz best ter run away ef there's a chance of fightin'.)
I dew believe a suction plant will run on anything,
From pit-head smudge tew stale tom-cats and little bits of string.
The fuel costs will therefore be extr'ordinary low.
(And you can bar the engine round in case she doesn't go.)
In short, I firmly dew believe in humbug generally,
For scientific statements hev uncommon little vally.
And, ef my monthly sales-account 'll only come up higher
I'll simply smile with saintly grace when called a little terminological inexactitudinarian.

BENEATH NIAGARA.

UNDERNEATH the cataract of Niagara, from an opening beneath the Horseshoe Falls to a pit sunk behind a cofferdam in the bed of the river, two thousand feet up stream, a tunnel has been bored as an outlet for one of the new electrical development companies. Its construction was made possible, says *The World To-day*, by two of the most thrilling journeys ever undertaken by workmen.

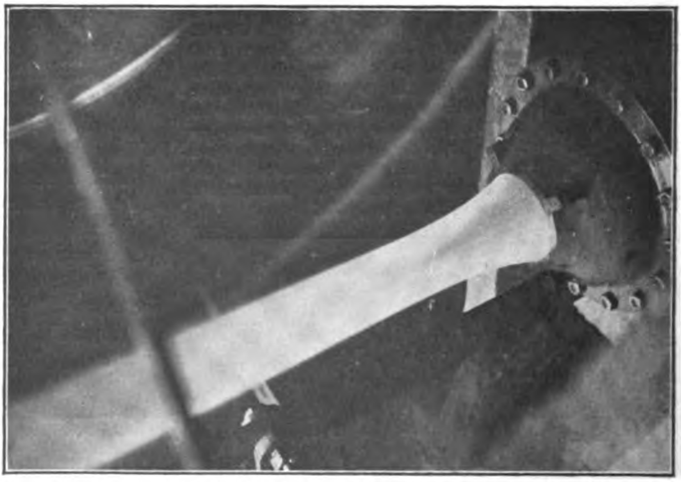
When the big tunnel—it is twenty-six feet high and twenty-three feet wide—was to be begun, neither end of it was within the reach of the engineers, for one was seven hundred feet out from the shore, behind the veil of the falls, where no man had ever been, and the other was one hundred and fifty feet beneath the cascades. An approach tunnel was therefore drifted out from shore, one hundred and fifty feet below ground under the brink of the falls, towards the site selected for the portal.

To avoid bringing all material to the surface for dumping, the engineers had a side tunnel bored to empty beneath the falls. Where it opened lay a huge pile of débris, and as soon as the opening was made spray from this pile began to fill the tunnel. It came in so fast that work was abandoned. Pumps were started, but still the water rose till it was sixteen feet deep in the shaft on the shore. It looked then as if the whole enterprise, on which a fortune had been spent, would be a failure.

Then three foremen employed on the work volunteered to go through the tunnel in a skiff and blow away the débris. They secured a punt from the Maid of the Mist and lowered it down the shaft. The water was within two feet of the roof of the tunnel, but they determined to make the journey. They loaded their boat with dynamite and electric wire and enough iron to sink it till it would allow them to move along the tunnel. Then, lying on their backs, they pushed the boat along the waterway by pressing against the roof with hands and feet. They persevered, and at last reached the portal through which the water was entering.

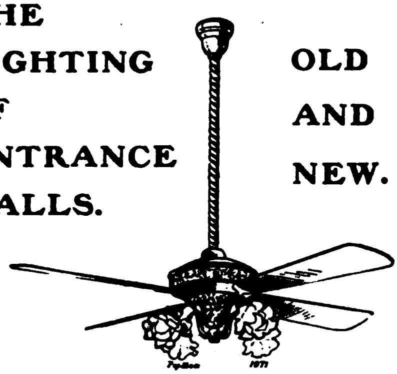
There it was they carefully fixed the dynamite in place. Returning with the wires which were to fire the charge, they upset their skiff and had to swim much of the way, but they arrived in safety—only to find upon touching the button that they had not taken enough dynamite to finish the work.

Then a new trick was tried. A line of volunteers, roped together like Alpine tourists, went along the heap of débris, behind the fall at the foot of the horseshoe, carrying dynamite in large quantity. These men, too, were travelling in a place where no men had ever before been. On the way one of the boxes of dynamite was dropped and burst open on the rock, but fortunately did not explode. The rest was buried at the entrance of the tunnel. At midnight that night there was an explosion which shook the American side of the river like an earthquake—and this time the effort was crowned with success. The water flowed out quickly, and thenceforth work in the tunnel was prosecuted with ease.



How falling water is used to drive a wheel. A jet of water leaving the nozzle and impinging on the water buckets.

THE LIGHTING OF ENTRANCE HALLS. OLD AND NEW.

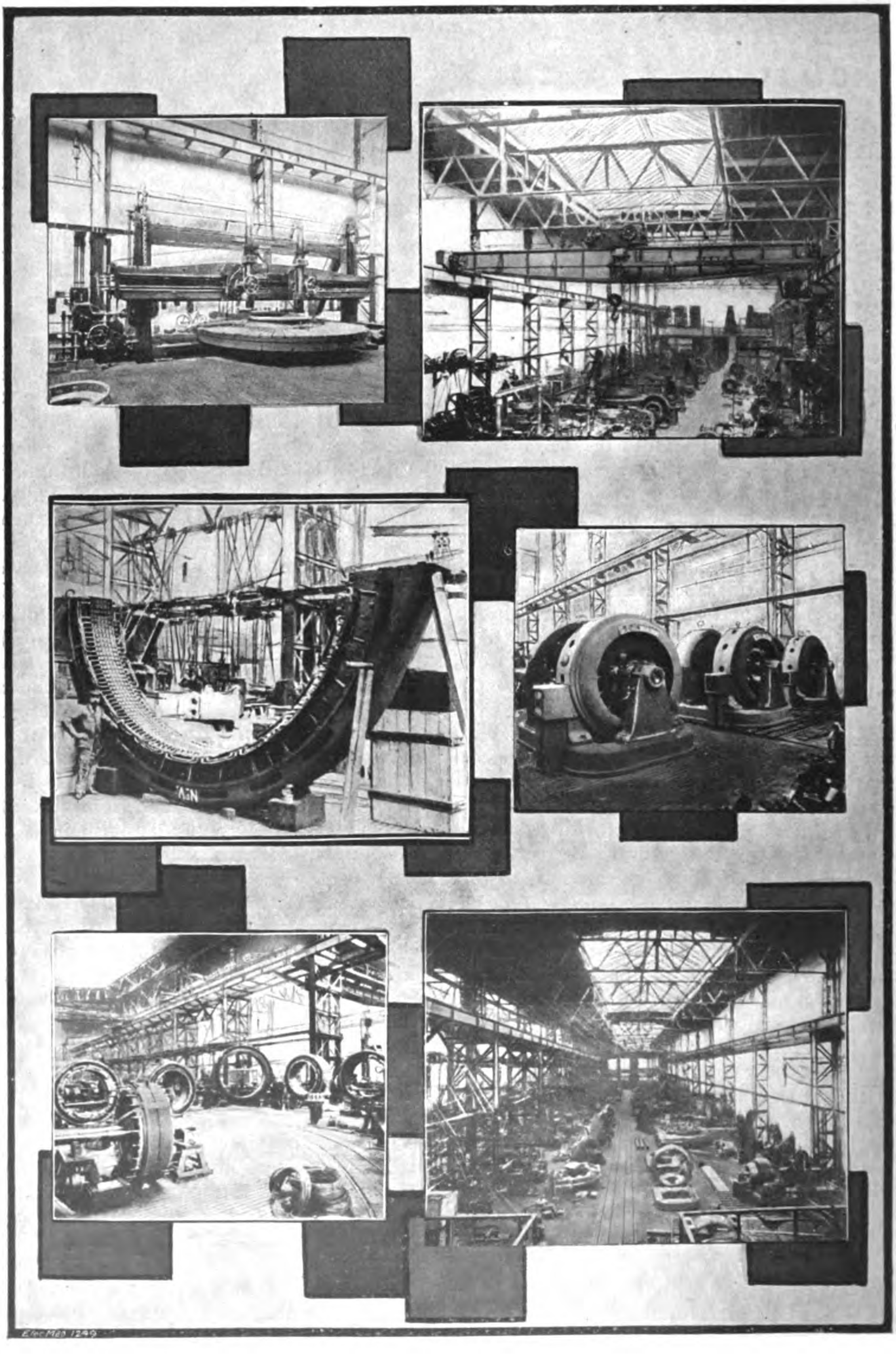


PUBLIC thoroughfares are nowadays, as a rule, well lighted, but sometimes—especially in Suburbia—a little private enterprise is needed to augment the general illumination. Who has not had within his experience the misery of doubtfully fumbling along a murky street, walking—delicately as the sons of Agag to keep unruffled the susceptibilities of unintroduced dogs and men—upon unknown garden-paths, and striking uncertain lucifers (with Luciferian comments) wherewith to decipher numbers and names of houses which are, as James Yellowplush describes it, "wropt in a mistry"? It takes a brave heart and the certainty of a welcome to pursue to the end the search for a strange house—a search that might be rendered easy had the owner the fellow-feeling to place in his porch a beacon of electric light to fling a ray of guidance down the path and throw into prominence the distinguishing name or number of the house. So much depends upon little details of foresight and sympathy.

There are, however, not wanting signs that the tendency of modern life is to look after the little amenities that go to make up comfort. Compare, for instance, the entrance halls that formerly struck awe into the soul of the visitor with those which have now replaced them. At one time the decorous servant ushered the entrant into an oblong box, at the further end of which certain steps led inevitably up, and others led inexorably down. Side doors opened into apartments known as "sitting" and "dining" rooms. Breast-high wainscotting of sombre hue suggested barricades: above was a yellow, shiny paper cunningly streaked with blue veins so that the whole did *not* resemble marble. This was relieved at intervals by oleographs having trenchant colour schemes, or by steel engravings concerning Biblical matters, horribly and emphatically framed in gilt. Against the wall would be placed a "hall stand" whereon a congerie of damp overcoats, dusty hats, and muddied umbrellas were assembled and gave a not uninteresting odour to the hall. And, above all, flickering in the draught created by the opening of the door, there was in every probability a turned-down gas jet, supported by and encompassed with massive brass tubes and scrolls which effectually prevented such light as was developed from penetrating the chilly gloom of the entrance. Truly a cheery reception-room!

The modern entrance is somewhat less sepulchral. There is not the same effort to preserve geometric precision, but considerably more skill and taste is shown in the production of a cheerful and artistic appearance. The wainscot is still there—it is a hygienic and ornamental feature—but it is not funereally dark. The floor is parquetted: care is taken in choosing harmonising tints for the frieze and wall; palms and old brass take the place of "Abraham's sacrifice of Isaac"; electric light sheds a radiant glow on the visitor, and the hall is rendered warm and cheerful by an electric radiator. Modern ideas of the fitness of things demand that the array of overcoats and caps, which formerly hung in melancholy collapse before the visitor, shall be banished from what after all is a reception-room; and there is now usually constructed a side-room where these are placed, where there is a convenient wash-stand, and where the tennis-rackets and other paraphernalia of outdoor sport are stored.

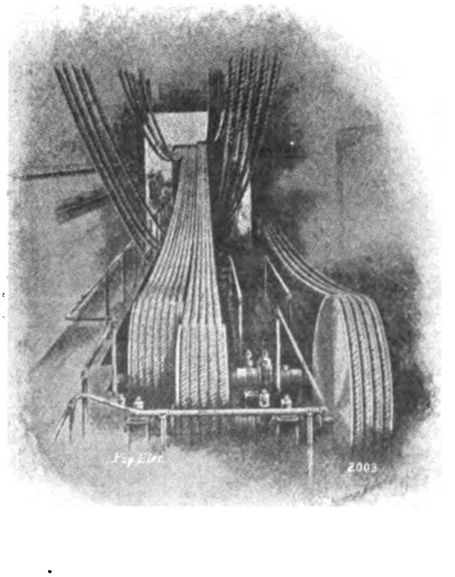
Such attention to detail may seem immaterial; it may be objected that in any but large houses the ground space for such an elaborate entrance cannot be spared, and that the remedy is to tell the visitor to "come ben" and forget the weather and all outside. But an old proverb has it that "first impressions are strongest," and it is therefore evident that hospitality, to be effective, should begin on the threshold. Space economised to the extent of cramping a welcome; light and heat saved to the extent of producing a mental as well as a physical chill, are evidences of penny-wisdom allied with pound-foolishness. Friends are worth making and keeping, even at the expense of a good hall light.—*Tyneside Electrical Pioneer.*



How Electrical Machinery is made. Views in the Shops of a large Manufacturing Electrical Works.

You can't get around This!

*I*t is a true saying that "every dog has his day," and "give a scamp rope enough he will hang himself." The association of ropes with hanging is singularly appropriate to what immediately follows. Those guilty of social misdemeanour must accept the inevitable consequences. Similarly, any guilty of industrial misconduct must be prepared to be rewarded accordingly. Industrial misconduct may be described as a too rigid adherence to old-time methods, with risk of commercial loss, and, moreover, with danger to life and limb of employer and employee alike.



Fly-wheels will burst when overrun, and ropes will break under excessive strain.

We need not dwell too long upon old-time methods in this case. From a host of examples we have selected the heavy fly-wheel and the rope drive. These embody the incongruous ideas of a particular school of thought—the steam school. A steam engine had of necessity a large fly-wheel, and the most natural method to adopt in utilizing its power was that of rope and pulley. Huge revolving masses thereafter became the common danger of workshop, mill, and factory, and soon a casualties list was started which has swollen grimly ever since. Fly-wheels will burst when overrun, and ropes will break under excessive strain; both spread destruction and death around.

Removed long ago by the "junk" cart and consigned to the scrap-heap.

These are old-time methods. They should have been removed long ago by the "junk" cart, and consigned to the scrap-heap of industry. They have become obsolete, and a better substitute should now be doing their work.

It is the duty of machinery users to rigorously cast aside all that threatens their interests and imperils the lives of their servants. The example of enterprising competitors should be strenuously followed, and full advantage taken of results fresh from the inventor's hand.

Fly-wheel and rope in the monstrous form given them by steam are now to be shunned, because the service they gave can be so much more economically and safely rendered by electromotors. To concentrate power in a single engine, and transmit it from the rim of a monster fly-wheel by ropes, is now an industrial sin, and, like wickedness of another sort, it exacts its price for the breaking of the new law.

Millstones.

The ancients of our race were very partial to stones, and used them for a variety of purposes. We, in our time, put our trust in iron and steel, but retain symbols of bygone days in common phrases applied to fit the needs of particular cases. A man is spoken of as having a "millstone round his neck" when encumbered with some hindrance which retards his progress in business. In the industrial world it might be more appropriate now to say that a man has "a fly-wheel round his neck," or "is encompassed about with belts and shafting so that the last state of that man seemeth worse than the first."

Have you a millstone round the neck of your business? Fly-wheels, belts, ropes, shafting, and gearing go to make up the burden of your troubles, and you find it heavier than the back of your business can bear. Needless devices between the power agent and the machine are millstones, and should be cast aside for more direct methods. Power at the point of use is what you need, and in the electromotor you can get it.

Have you a millstone round the neck of your business?

Drive your argument well home when advocating the use of electricity.

Figure it Out.

What balance you put on the right side every year by using electric light.

◆ ◆

What San Francisco would now be worth if it had not commissioned both gas and electricity to do its lighting.

◆ ◆

How long it will take for electric 'buses to run the petrol variety show off the roads.

◆ ◆

What extra profit you have netted since you threw out your gas-engine and used an electromotor.

◆ ◆

What motoring without electric ignition would mean to you, and where the motor industry would be to-day if it had not been possible.

◆ ◆

Whether, with all its overwhelming advantages, electricity is not worth installing in place of gas, both for lighting and power.

◆ ◆

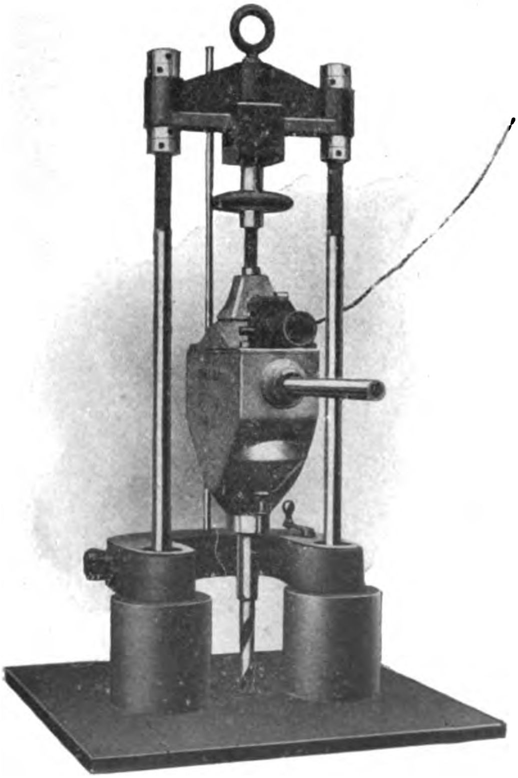
How it would feel having a tooth filled with a baby gas-engine driving the dental motor.

Things you ought to Have.

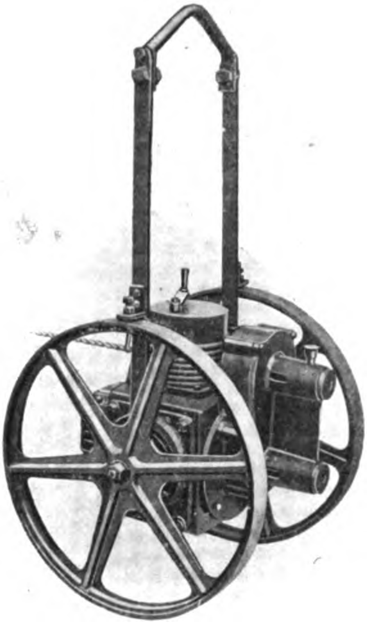
You may always turn to this page for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

Miniature Electric Drills.

WHAT is the use of bringing the work to the drill when the thing can be done so much easier the other way about? If the work weighs many hundredweights, or even tons, the moving of it up to a drill which is but a tithe of the weight is ridiculous. Electric drills are light and handy. They can be easily carried up to the work and quickly put into service. With a magnetic drill pillar, no rigging tackle is needed. The drill is centred over the punch mark and current turned on to the magnets, when the thing is as solid as if keyed or wedged. Much more convenient than wasting time with wood blocks, chains, ropes, and drifts. The drills illustrated on this page are made by Kramos Ltd., Bath, and a postcard application will bring by return a dainty booklet describing them. It will be worth the halfpenny outlay involved.



Vertical Electric Drill, with magnetic drill pillar holding the supports firmly down to the work.



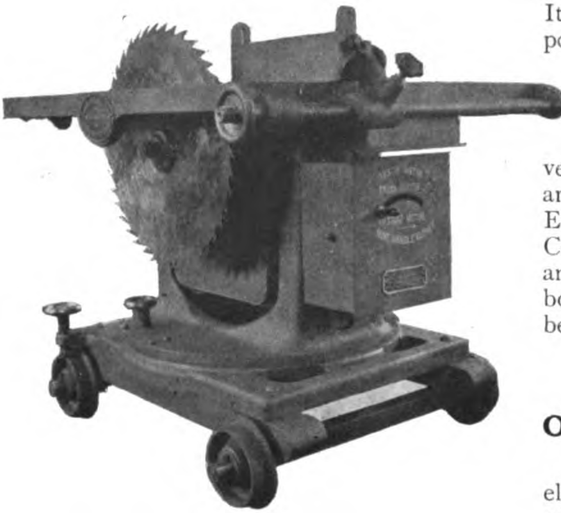
Tiny electric drills mounted on truck for conveyance about works and yards.

Electric Buffing Machines.

Turn to page 71 of this issue if you want a handle electric buffer in your workshop. It is made by Electromotors, Ltd., Openshaw, Manchester, who will send illustrated particulars and prices immediately on request. Silversmiths and jewellers, here's a chance!

Small Workshops.

The workshop employing upwards of say a dozen hands can just as well reap the advantages of electric power as can a monster establishment. It must not be supposed that electric power is only available for the monster motors of hundreds of horse power. It will serve the interests of the humbler machine giving but a tithe of this output.



A Self-contained Electric Saw Bench.

An Electric Saw Bench.

Timber merchants are accustomed to bring the trunks of trees and planks from the stacks to the saw bench in the sawing house. This is not always convenient, and it would save much time if a saw could be applied on the spot in the timber yard. With steam and gas engines saws must be driven by belt or rope, and a portable saw would be an impossibility. Electric power, however, makes the portable saw a commercial reality and a type of tool which the timber merchant has long needed. As will be seen by the illustration at the head of this column, the bench is exceedingly compact, and includes motor, saw, and starting box. The current is conveyed by a flexible cable, which enables the bench to be wheeled to any convenient position where work is to be done. The speed of the saw can be regulated at the starting handle for hard or soft woods, according to the class of timber going through. The Sunderland Forge and Engineering Co., Ltd., Pallion, Sunderland, make benches of this kind, and will be glad to supply all information needed on request.

◆

Nernst Lamps.

Light users who need a good white light from a compact lamp without the mechanism of an arc lamp should see the Nernst lamp. It is now standardized for various candle-powers, and can be supplied at once from stock for the voltages regularly available. The lamps have become very popular, and deservedly so, as they furnish a soft white light which has a pleasing effect and is very suitable for situations requiring a medium amount of light. The makers are the A.E.G. English Manufacturing Co., Ltd., 4/5, New Compton Street, Charing Cross Road, W.C., and they have many interesting and tasteful booklets on the subject, copies of which will be forwarded on application.

◆

On Seeking Advice.

Don't be in too much of a hurry to install electric light or power without taking expert advice on the subject. You can get anything too cheaply and afterwards regret you had not spent a little more. This applies to electrical installations, and for the sake of the slightly increased outlay it is always better to have sound advice.

◆

Bell Batteries.

Electric bells will "strike work" unless they are coupled up to a good battery. The "wet cell" is generally used to supply the current for bells, and there are many forms on the market. The type illustrated below is furnished by the General Electric Co., Queen Victoria Street, E.C., and is stated to be specially suited to electric bell circuits.

A convenient and efficient form of "Wet" Cell for electric bell service.

PROFUSELY ILLUSTRATED. ONE PENNY.

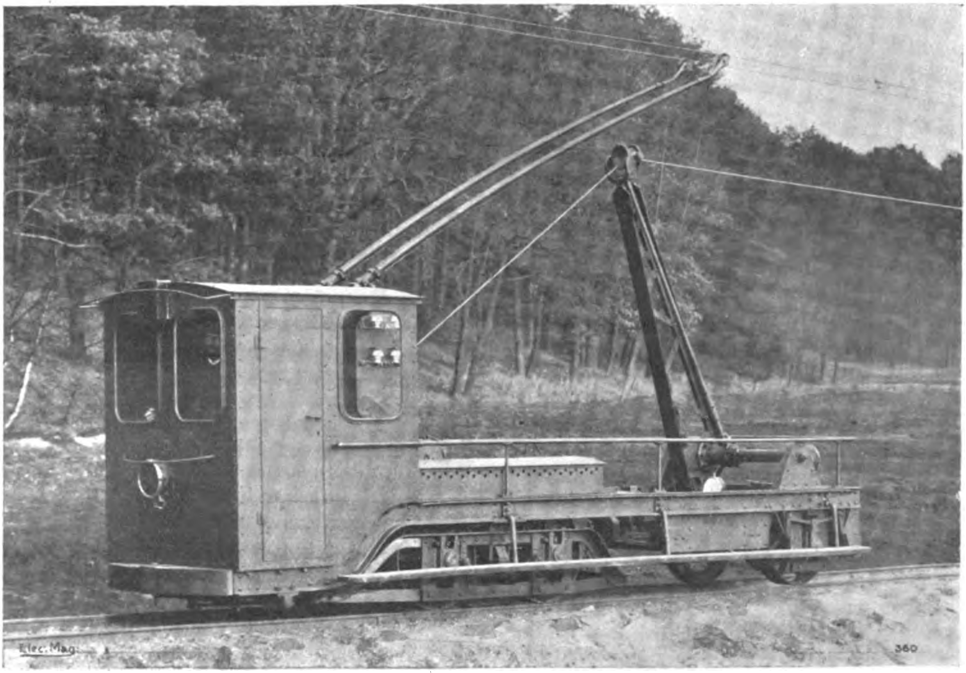
POPULAR ELECTRICITY

Electric Towage on Canals.

The canals of Great Britain are not made full use of because they are owned by the railway companies, who prefer to develop their main-line traffic at the expense of more efficient waterways. A canal barge is a deceptive vessel—that is, to the casual observer; it does not seem to hold much freight and appears generally clumsy and probably antediluvian. But canal boats vary in capacity from 50 to 300 tons, and the lighter forms can be easily hauled by one horse. On land one ton is considered a good average load for a strong horse, so the difference between water and road, and even rail, haulage is very greatly in favour of the former from the point of material transported at one haul.

Experiments in different parts of the world are now being conducted to ascertain the value of electric haulage for canals, and already trial lengths are in operation.

The chief economy is hoped for in the increased load hauled at lower cost, as the present rate of speed cannot be greatly advanced, owing to the risk of washing away the banks. The picture below shows an electric "horse" or tractor running on rails at the canal side, and receiving power for its driving motors from two overhead wires.



Modern Electric Canal Trolley Tractor.

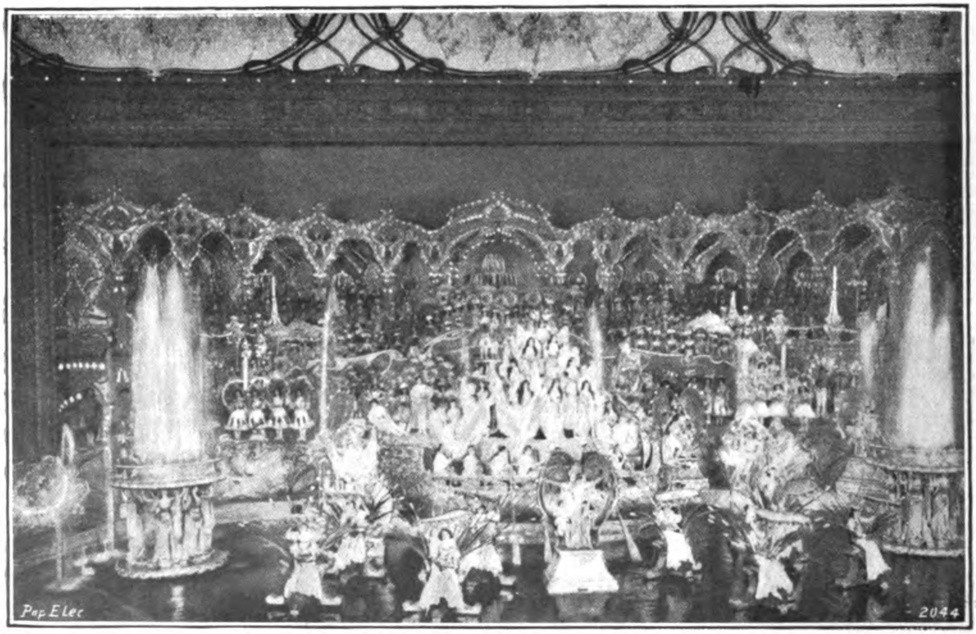
Safety in Theatre Displays.

If we thought of the risks we run in attending a theatre we should probably be seldom seen inside such a place of amusement. Anything and everything might happen to us, because the stuff that theatres are made of is the essence of danger when disturbances arise. But no; we do not, or will not, think of such things, and complacently fill our allotted seats, with our minds intent on the pleasures of the play.

The same restless spirit, however, which now hurries us along the road of life has cast a spell upon the theatre, and transformed its placid scenes and plays into a whirligig of ever-changing effects, which merely create a craving for further feverish movement behind the footlights.

To-day we see constantly that the public taste has changed in matters histrionic, and it now demands variety in its most extreme and certainly its most splendid degrees, or it withdraws its patronage. This desire must be catered for, and extravagant and ambitious are the ideas of the management of a modern variety entertainment. Compared with stage effects of a few years ago, the "feats" of the present time are daring in the extreme: and, in fact, they could not have been produced at an earlier time because the "mere machinery" upon which they depend for their attraction was not then available.

The whirling stage of the London Coliseum is only made possible because the electro-motor alone can revolve it efficiently and safely. The brightest of ballets and most startling of scenes of the great variety shows of the metropolis can only be realised by the aid of electricity, without which if they were attempted the danger and risk would be enormous.



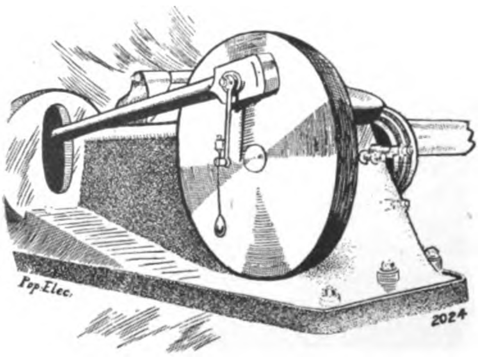
An Electric Spectacle at the New York Hippodrome.

The picture on this page is a dazzling testimonial for electricity. It shows the Hall of Fountains scene produced at the New York Hippodrome, depicting, though somewhat imperfectly, the amount of light employed. The stage is thronged with figures, and the centre setting, with its fountains on each side, is lovely beyond words. The dancing jets of water are all lighted by changing coloured rays from thousands of lamps, and the general display of brilliance exceeds anything yet put on the stage.

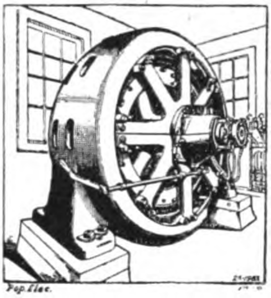
Right and Wrong Principles.

When mechanical powers were first placed at the disposal of industry there was little to choose between the methods of applying them to the needs of the time. With the exception of water-wheels, the early prime movers—steam and gas—were all provided with cylinder, piston, connecting-rod and crank, and down to the present day this idea remains embodied among the majority of the engines built. The pioneer was practically "tied up" to the crank and piston, and, in fact, he could conceive of little else. Considering that in most cases he wanted his power in rotary motion, it seems strange he did not think of obtaining it direct in the prime mover. But he didn't, and industry to-day is badly off in consequence. It is fettered to a thing which no amount of ingenuity can improve beyond a particular point. This is because the principle is wrong, and therefore nothing remains but to proceed on another tack.

It must be particularly borne in mind that 85 per cent. of industrial operations require direct rotary motion. Cranes, hoists, lathes, mills, textile machinery, all tractive devices, boring, drilling, and many other processes depend entirely upon what we may call pure rotation. Obviously then it is needless waste of time and money to furnish them with mechanical devices which are reciprocating first and rotative afterwards. To concentrate power in a huge fly-wheel and transmit it by ropes and belts is sheer mechanical barbarism. It might do credit to the neolithic age, but in an era of iron, copper and steel it should not be countenanced any longer.



"The pioneer was 'tied up' to the crank and piston."



"The soft whirr of motors must take the place of clanking levers and bumping piston rods."

Similarly to employ cylinder, piston, and crank for secondary-power work is folly in the essence, and a deliberate contravention of known mechanical laws. We cannot criticise it too emphatically, because we want to see it done away with. "Pure rotativeness" is the poetry of motion, and now that it is obtainable wherever an electricity-supply station exists there is no excuse for adherence to antediluvian ways.

The day has now dawned when the cumbersome mechanical adjuncts of old-time power agents must be relegated to the limbo of forgotten things. They have sprawled over the face of commerce long enough, obscuring the good in industry and only throwing into relief the evil effects of their own influence. All this must be reversed now that we have electric power in our midst. The soft whirr of motors must take the place of clanking levers and bumping piston rods, and even in the electric power house the monster engine, with its towering cylinders and horrific fly-wheel, shall no longer be allowed to raise its graceless head.

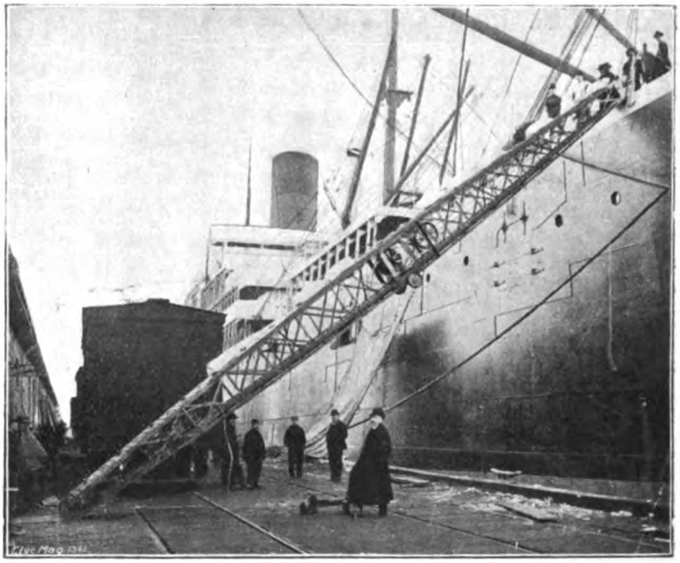
The principle of the electro-motor is, then, the right one. Within the compass of its compact form the elements of motion are embodied, and in its whirling shaft and pulley they give themselves practical effect.

Order the back numbers of

Popular Electricity.

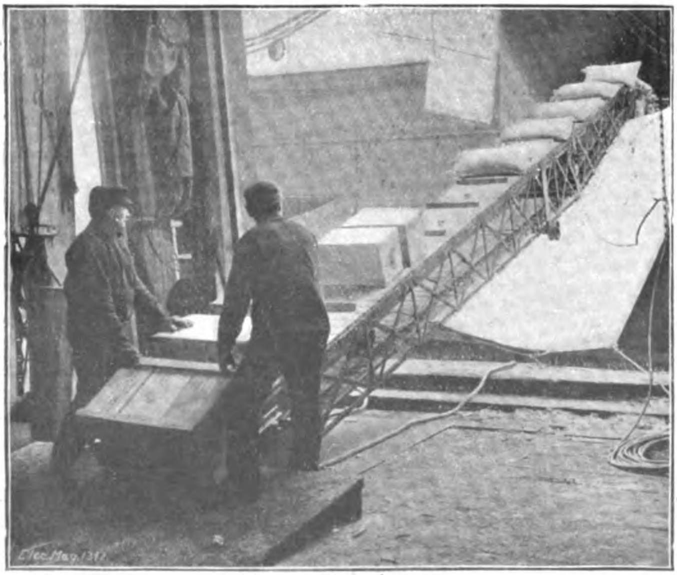
They will interest you.

Electric Shiploading.



A New Form of Electric Elevator for the Transport of Goods to the Deck of Ocean Liners.

A HUGE liner standing in dock at high tide is difficult of access for both goods and passenger, but the former especially are troublesome to get aboard, because they want "helping in." Electric power however comes in useful here, as will be seen by the pictures on this page. They depict a new form of portable elevator by which goods can be quickly and regularly raised on deck or conveyed into the vessel's hold. The device consists of a motor-driven "apron" or moving platform which is constructed to be endless so that it gives a regular feed. The apron is driven to travel towards the vessel, and goods placed upon it are carried up to the higher level. Projecting pieces on the slats prevent the packages slipping down when the elevator is tilted at a very sharp angle. The framework is quite lightly built and is fitted with small wheels which enable the elevator to be run along the wharf to another vessel. The motor drives the platform through suitable gearing, and the speed can be adjusted to suit the class of freight being drawn on board. All modern harbours are now provided with an electricity supply, so that the supply of power to an elevator of this kind is a matter of extreme simplicity. Its use in practice lowers the cost of loading miscellaneous freight very considerably, because only low-powered motors are needed to drive the mechanism. The height of the vessel makes no difference to the employment of the elevator, one of the pictures showing it in use at a steep angle delivering goods over the bulwarks, and the other at a lower elevation, raising freight to the second deck of the vessel.



The Electric Shiploader in use, showing Boxes and Bags being run into the Ship's Hold.

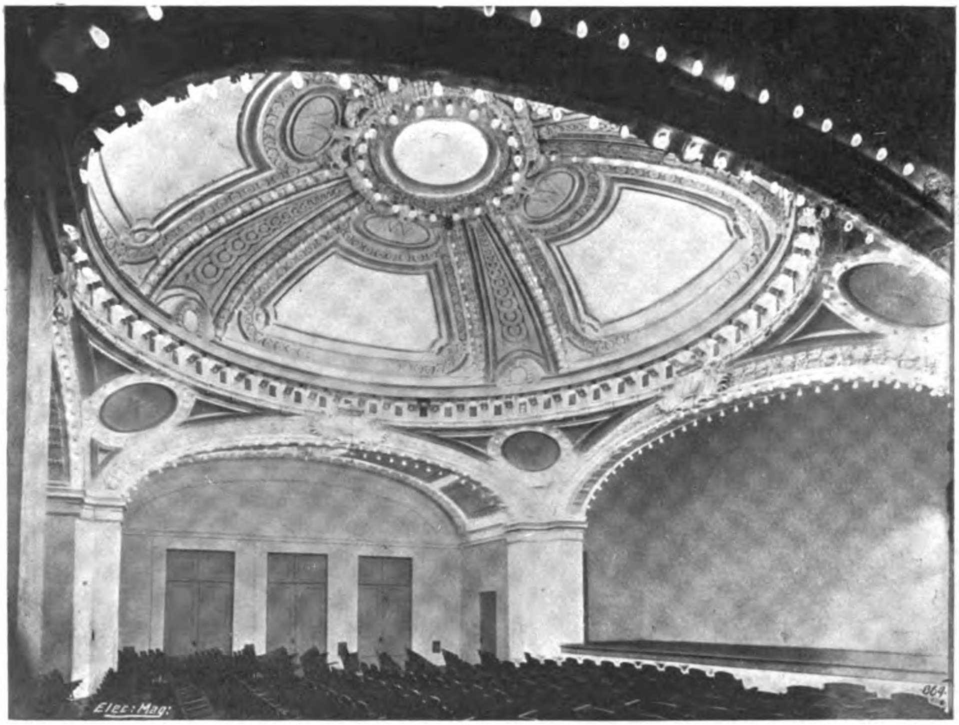
Effects with Ceiling Lights.

The Beauties of Electric Lighting.

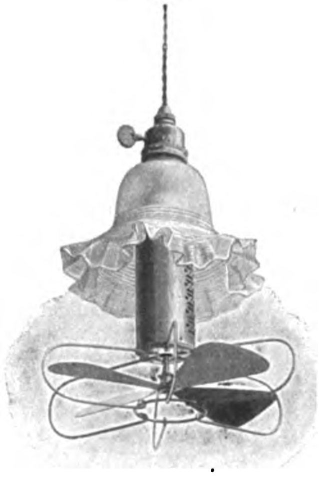
THE ceiling of a room is the ideal place from which light can be diffused and reflected into a room. The sun is in "the ceiling of the world," and from the distribution of its light we gather that an elevated position is the best for an illuminant. If it were not so an all-wise Providence would have arranged the world's lighting department in a different way.

We are justified then in believing that lights fixed in the ceiling, in some admittedly efficient position, afford the best kind of illumination for a room. In practice it is difficult to stud the ceiling with lamps and secure an even distribution of light, and only in very special cases are lamps placed in the ceiling at all. The picture below is an example which will not be commonly met with, but which is an excellent instance of ceiling lighting. We do not propose to describe it in detail, but reproduce it here because it fittingly serves to illustrate our remarks on ceiling lamps.

Small rooms can be very efficiently and pleasingly illuminated by reflected light, when lamps are sunk at the back of the picture rail, and reflectors used to throw the light rays on to the white ceiling. It is one of the prettiest forms of interior lighting, and with elongated lamps specially constructed the distribution can be made very even and without patches. We need hardly say that such an effect can only be obtained with electricity, because gas would speedily cause a conflagration, and even if it were adapted the walls would quickly show the marks which always accompany its evil presence.



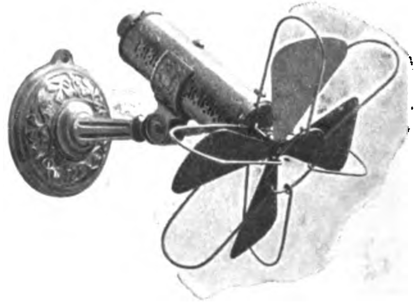
A typical example of the splendours of Electric Ceiling Lights.



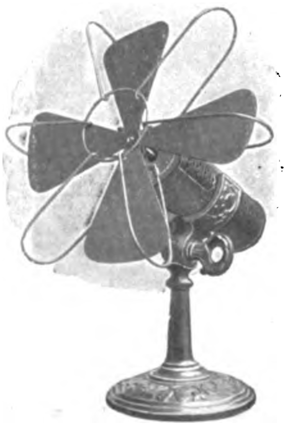
Fan Motor inserted into an ordinary pendant holder.

Lampholder Fans.

THE lampholder fan is probably the last word on the electrical production of cooling breezes. When the first electric fan was produced it certainly would have been difficult to suggest any improvement upon it, or any other form than that in which it first appeared. Ever since electric power became commercially available electric fans have been very popular, because they are the essence of neatness and can be so easily controlled. The lampholder fan, as its name implies, is designed to operate from an ordinary lamp holder, the socket at the base of the fan being inserted in exactly the same way as a lamp. From the illustrations on this page it must be perfectly obvious that this little breeze-creator is extremely light, in that the thin flexible cord of an ordinary pendant will support it without undue strain. It will also be noticed that the fan can be placed in a special holder, which admits of it being either stood on the table or hung up on the wall. In these two instances the same kind of holder is employed; but a flexible connection is required, which is fitted either with the common form of bayonet socket or a two-prong plug for insertion in a wall socket. The little motor consumes no more current than an ordinary lamp, and will run continuously without attention for a very long time; in fact, as long as the bearings are properly oiled the fan needs no attention whatever. This new development in electric fans should raise visions of cool days in the heat and oppression which the summer is sure to bring. A device of this kind should find its way into the house of every user of electric light, because the initial cost is exceptionally low and the current consumption also is remarkably small. There is no other electrical device on the market at the present moment which can afford the small users of electric power so much comfort during sultry weather as these little fans. Through the courtesy of the National Telephone Company we are enabled to present our readers with the views on this page. If any of them are interested and would like to obtain further particulars, they will find the address of the company on page 96.



Lampholder Fan as fixed in holder for wall or bracket use.

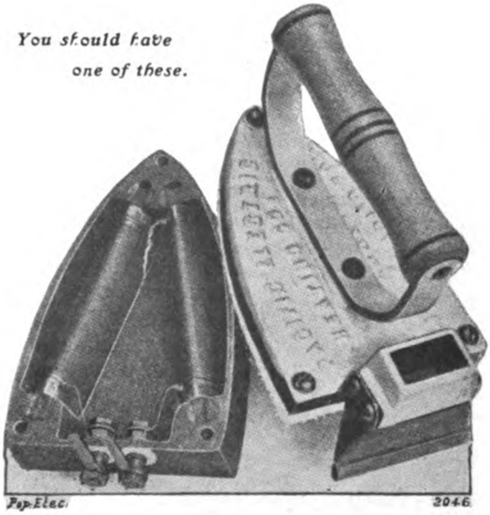


Lampholder Fan clamped in portable stand for desk and table use.

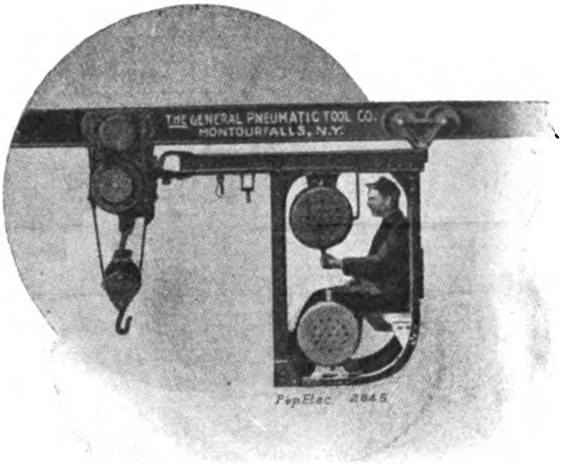
The Electric Iron.

It must not be supposed that because electricity will light a lamp, charge a battery, drive a train, or turn a motor, that it is not equally available for heating purposes. It may seem strange, but it is easier to get heat from electricity than anything else, though at its present price it cannot compete, on the score of cost alone, with its rival gas. Still, a very flourishing business is being done with electric heating apparatus, and some very useful devices are now on the market. One of the earliest applications of electricity to heating was to the familiar domestic iron, and when electric irons have once been used one can always depend upon their remaining in active service.

We illustrate below one form of iron, which is specially designed to give great heat at the point. It will be noticed that there is no complicated mechanism in the interior, simply two plain coils of wire which constitute the "heating department." When the lid of the iron is in position the terminals for the wires carrying the current are quite concealed, so that it is impossible to receive a shock. On the score of convenience the electric iron is far and away ahead of anything in the domestic iron line.



An Electric Heating Iron with top removed, showing heating coils and connections.



An Electric Runway in use on overhead girder.

Electric Runways.

The various workshops of a modern manufacturing establishment are now generally connected up by lines of railway which serve for the transport of heavy goods. The operation of trains for quite light material is, however, undesirable and costly, but mechanical transportation of some kind is necessary, as hand labour is likely to be too slow. The overhead runway has been considerably developed of late years, and it is to be seen in most large industrial establishments, plying from shop to shop about the works. The illustration at the head of this column depicts how the electro-motor has been applied in this particular field of transport. It will be seen that from a pair of small bogies running on the inside of an inverted girder a special cradle depends, at one end of which is the driving-motor, and at the other a cage containing the man who regulates the various operations. Directly in front of him are the controllers, by the actuation of which he can travel backwards or forwards and raise or lower the load. Current is supplied to the motors either by way of the wheels or from a small trolley wire strung at the side or above the girder.

A device of this kind is very cheap to install and operate, and will be found extremely useful to connect up a number of workshops or buildings of a straggling nature.

Something to Make.

A Toy Steam Engine.

A TOY engine can be easily made from old implements which can be found in nearly every house.

The cylinder, A, Fig. 1, is an old bicycle pump, cut in half. The steam chest, D, is part of the piston tube of the same pump, the other parts being used for the bearing, B, and the crank bearing C. The fly-wheel Q can be any small-sized iron wheel; either an old sewing-machine wheel, pulley wheel, or anything available. We used a wheel from an old high chair for our engine. If the bore in the wheel is too large for the shaft it may be bushed with a piece of hard wood. The shaft is made of heavy steel wire the size of the hole in the bearing B.

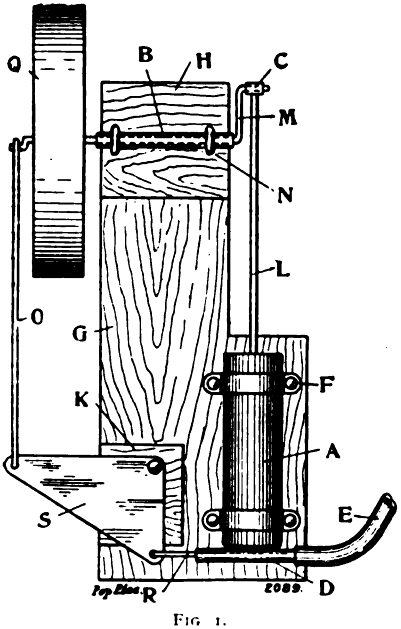


FIG. 1.

The base is made of wood, and has two wood blocks, H and K, $\frac{3}{8}$in. thick, to support bearing B and valve crank S, which is made of tin. The hose E connects to the boiler, which will be described later. The clips F F are soldered to the cylinder and nailed to the base, and the bearing B is fastened by staples.

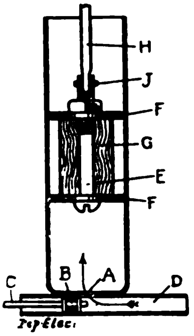


FIG. 2.

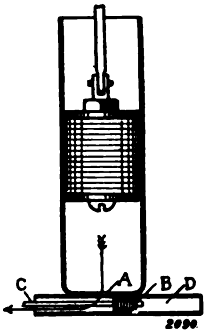


FIG. 3.

The valve motion is shown in Figs. 2 and 3. In Fig. 2 the steam is entering the cylinder, and in Fig. 3 the valve B has closed the steam inlet, and opened the exhaust, thus allowing the steam in the cylinder to escape.

The piston is made of a stove bolt, E, Fig. 2, with two washers F F, and a cylindrical piece of hard wood, G. This is wound with soft string, as shown in Fig. 3, and saturated with thick oil. A slot is cut in the end of the bolt E to receive the connecting rod H. The valve B is made of an old bicycle spoke C with the nut cut in half and filed down as shown, the space between the two halves being filled with string and oiled.

The valve crank S, Fig. 1, is cut out of tin or galvanized iron, and is moved by a small crank on the shaft. This crank should be at right angles to the main crank. The boiler can be an old oil can, powder can, or a syrup can with a tube soldered to it, and is connected to the engine by a piece of rubber tube.—*Popular Mechanics.*

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All Communications to be addressed to 4, Southampton Row, Holborn, London, W.C.

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Sparklets.

Tantalum lamps were very tantalising at first because they were so expensive. They will, however, no longer tantalise. The price is reduced by nearly half, so we may expect to be "tantalited" in future.

* *

The picture on our first page this month depicts an electric tractor as used on the new Teltow Canal in Germany, just opened by the Kaiser. The canal is twenty-four miles long, and fifty bridges cross it. When will King Edward open an electric section of British canals?

* *

The Japs are getting a move on. Since their tussle with the Russian Bear they find coal has gone up in price 60 per cent., and this does not suit their taste for economy. Still they can't grumble yet, their islands abound in water-falls, and already these are being utilized to produce electricity. They only did a little rice and corn grinding previously.

* *

The Astronomer Royal complains of the new L.C.C. electric power station at Greenwich as interfering with his observations and the meridian. Bill Sikes suggests that he should "shift 'is blooming observitery, or, better still, that there merrijian."

* *

This seems *too* good to be true. Professor Adolphe Tamé, director of the electrical company "La Gada," at Oneglia, Italy, claims to have discovered a method of electrifying water so that it can be used to drive motor vehicles and to convey light or heat without difficulty.

* *

Great greased lightning! This sounds electric enough! It is from the Edison *Bulletin.* "The record of the new high-speed electric elevators in the Duane Street building of the New York Edison Company is very gratifying. With a speed varying from 500 to 600ft. per minute, they start quickly and stop exactly at the landings." Ye thunders! What if they didn't at the top storey.

* *

"What kind of light did Noah have in the Ark?" asked the fat man at the boarding-house table.

"Arc light?" shouted a dozen voices at once.

"No," replied the fat man, with emphasis, "the arc light was not invented then."

"Water gas," suggested a thin man, as he finished his prune.

"Wrong," answered the fat man.

"We'll give it up," replied several.

"Why he just had two tapirs."

Electric City.

The Value of a Good Sign.

How Electricity can bring in Business.

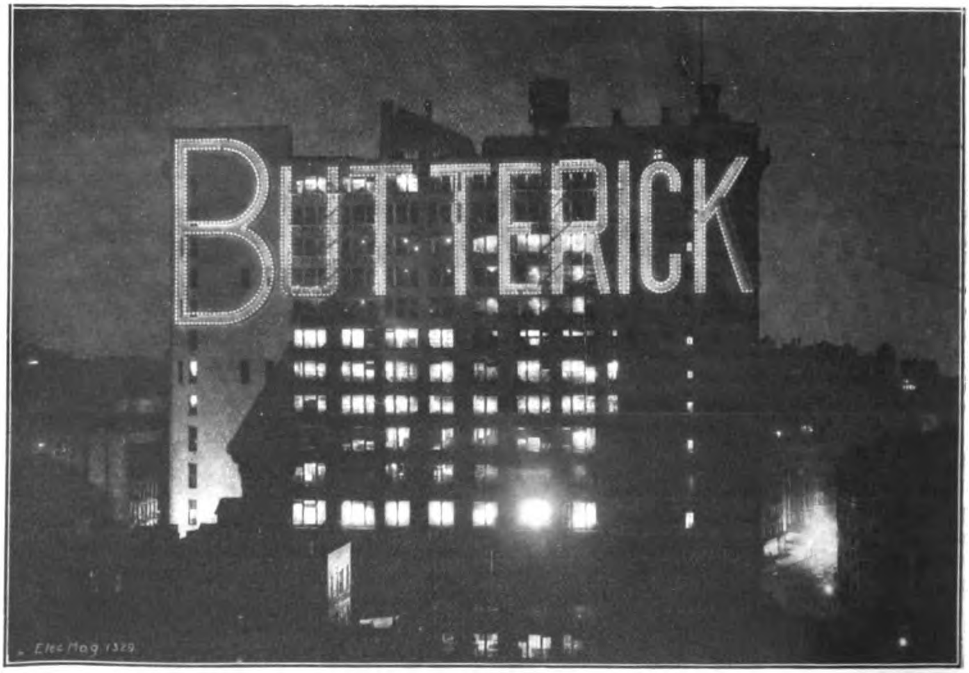
THIS is the age of advertising. Of course you don't want telling, but we must say something by way of introduction to a few words on signs. But you can't really know, that is you are merely pretending, if you don't advertise. There's no denying that the best "ad" is the illuminated finger-sign. Everybody passing your establishment sees it, and if it's properly done they will stop to look at it and then see your goods, and then they come inside, and *then* you do the rest.

An electric sign to be compelling must be done well. Don't look into your purse before you start and determine to spend only so much. Get the thing done, foot the bill, and look pleasant; afterwards look after the increased business. If you have done wisely with the sign you can't help getting the business.

Big signs are not for all and sundry trades. Everybody can't put up a "Butterick" sign like the one in the picture below, but they can profit by the good example set them in this the world's monster electric sign. It wasn't done properly at first—the effect was disappointing; but it got done again, and it can now be seen for miles out in the expanse of New York Harbour.

When you get your sign up see it is a good one, because you had better leave it alone if you can't make it good. Still, there's no need to be afraid of the problem. It will justify the labour you spend on it, and when it is just right you will feel the benefit. One last word. Don't let a good sign hang out too long. Give it a rest and try something else.

Finally, don't change too often; that's worse than no sign at all.

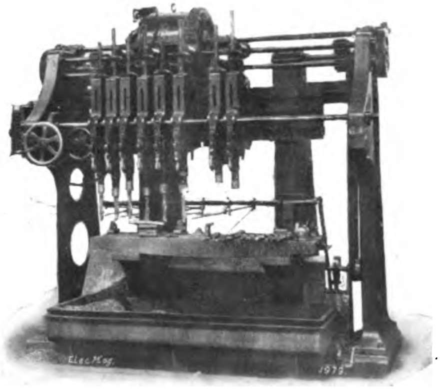


The famous Butterick Electric sign, the largest in the world, overlooking New York Harbour.

LITTLE MOTORS AGAIN.

We have not yet done with the little motor. It has formed the subject of several homilies in previous issues, but these do not exhaust the stock of information or advice we keep on this useful article. We present on this page three pictures which will tell a great deal better than words what the little motor is capable of. The illustrations are specially selected to catch the eye of the engineer who has a small workshop, and which is fitted with somewhat similar tools, but, unfortunately for him, driven by a gas or steam engine.

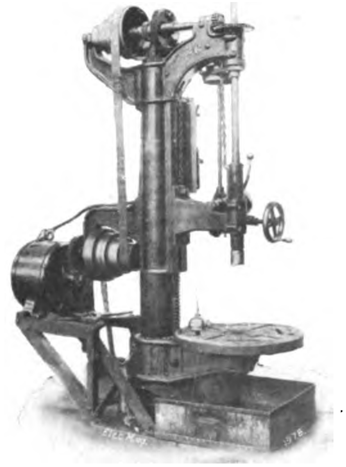
This is where we want a straight talk with ou, Mr. Engineer, and ask your close examination of the power problem which your machine tools set you. The types shown on this page, drills and a shaper, are best driven by some rotary form of power agent. The drills especially require direct rotative force, and a motor supplies this better than a gas or steam engine, because both these must be belted to shafting and cannot be applied direct. With a compact rotary power agent, such as the electro-motor is, you can get the energy you want *right down at the machine*, instead of at the far end of a line of shafting. As an engineer you must know that the soundest job is always the simplest; consequently it is simpler and sounder to carry your power through a flexible copper cable than by way of line shafts and bearing hangers.



"The plain motor is simpler and sounder than shafts and bearing hangers."

"Fit a motor to each tool."

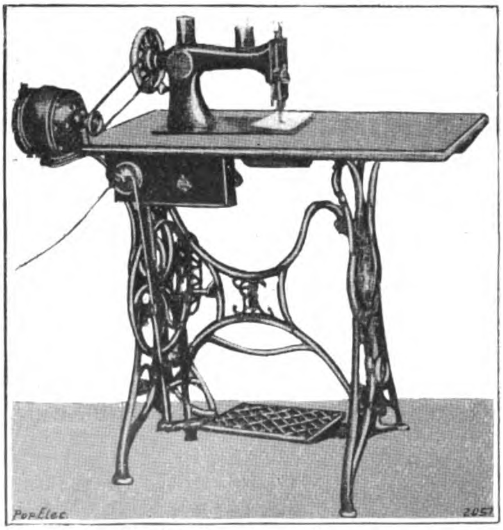
Of course our counsel that the old gas or steam engine should be taken out of your shop only affects you if electric power is available. If you are not in touch with an electric service you must put up with the inconvenience and loss with everything else. But when power cables pass your door, surely 'tis folly to adhere to a state of things which is constantly keeping down the profits of your business. If your workshop is too small to fit a motor to each tool, at least the next best thing you can do is to put a large motor in and "sack" the steam or gas engine. They have wasted your substance long enough.



"Drills especially require direct rotative force."

A Domestic Companion.

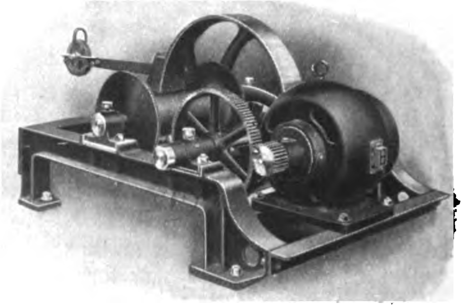
We have said a good deal in previous issues about what the small electro-motor can do, but we have never given an example of an electric sewing machine. On this page will be found a typical form of this handy contrivance, and the average housewife, after inspecting it, would say that the only new thing about it was a motor. As a matter of fact, this is actually the case. To drive your sewing machine by electricity, all you need is a motor, and, of course, the necessary electric power to turn it. Where mains are available outside your door, or when you have electric light in the house, the thing is as easy as "pie." If you can afford the expense of a small battery, this can be installed with advantage, and the motor will run in just the same way. It is attached to the table of the machine by a small clamp, and if it is necessary to remove it at any time it can be readily dismantled without interfering with the arranging of the sewing machine proper. It will be noticed that the switch is actuated by the treadle, so that the hands are free to manipulate the work, while the motor can be started and stopped just as if the machine were being driven by foot power. A motor of this kind will operate successfully off an ordinary lamp holder, and requires no other attention than the occasional oiling of its bearings.



Ordinary Treadle Sewing Machine driven by Electro-motor.

The Small Electric Hoist.

In these days of electric power it is really pitiable to see a man throwing his weight on a crank, and with a combination of expletives and sweat endeavouring to raise heavy weights. Similarly, one is apt to pity the man who spends his money on a steam hoist, which soon becomes a general nuisance and speedily knocks itself on to the scrap-heap. There is really no need for all this waste of energy. Light, compact, electrically-driven friction hoists are on the market for lifting weights from one hundredweight upwards, and at a speed of 100ft. to 150ft. per minute. With a device of this kind in a warehouse or store, and, in fact, in any position where light weights have to be constantly raised and lowered, the small electric hoist pays for its cost in a remarkably short space of time. The trolley is everything that could be desired. A man doesn't need to be an electrician; as long as he can pull a lever, and throw over a switch, he possesses all the necessary qualifications. The little hoist which we show in this column is the product of Electro-motors, Limited, of Openshaw, Manchester, who will forward full particulars, and a list of installations where hoists of this kind are in use, immediately on application. If you have got any hoisting to do, take advantage of this opportunity.



A convenient form of Electric Hoist.

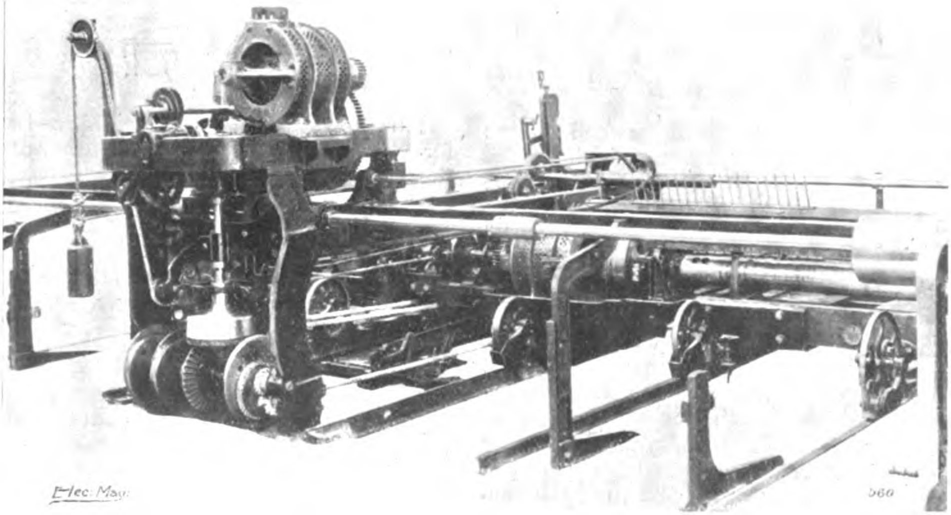
We are making electricity popular and Popular Electricity a household word.

Electricity and Spinning.

Where Electric Power saves time and money.

JUDGING by the manner in which electro-motors are being installed in the large textile mills in this and other countries, it would be no exaggeration to state that to all appearances the day of the spinning-wheel has gone for ever. The concentration of industries of every kind into large factories, and under one or two central controlling bodies, quite precludes the possibility of working on a commercial scale the domestic industries of the past. For the operation of textile machinery electric power is absolutely ideal. The large steam engines which are still to be seen in the cotton mills of Lancashire are useful enough in their way, but in principle they are radically wrong for driving the bulky machinery in the mills above, though it is not uncommon to find a monster beam engine slowly pulsating in the engine-room, and driving with measured beat a huge fly-wheel, from which bunches of ropes pass to all parts of the mill for driving the machinery on the various floors. Although there is a big fly-wheel fitted to steady the load and even up the pulls of the great engine, an absolutely regular turning moment cannot possibly be obtained from an engine of this class. All the machinery in the mill requires a purely rotative power, and this is best given by the electro-motor.

At one time mill-owners were prejudiced; they did not like the appearance of "them gimcrack electric things," and all attempts at persuasion were unavailing. Their old steam engines had served them so long that they could not abandon them for something which to their thinking was untried and probably unreliable. That was in the early days of electric power; now they are beginning to change their minds. In many instances they have only to go to the next town to find an example of modern electric driving which they can inspect at leisure, and when once an installation of this kind is thoroughly inspected there is no room left for doubt as to which is the better method—electric or steam. Experience is now proving it up to the hilt.

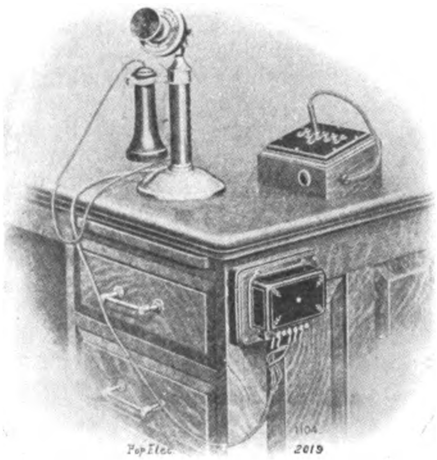


An Electrically driven Self-acting Mule.

The motor will be noticed mounted on the frame at the left, and it drives the mechanism of the mule through silent gearing.

At Your Elbow.

THE telephone puts the "universe" at your elbow, a thing hitherto unknown the world's affairs. Among the relics discovered amid the ruins of cities long since dead no trace of a telephone has yet been found; so at present our opening sentence can go unchallenged. The extraordinary development of the telephone has brought the business world close together, so close that the desk of every commercial man is in touch with that of his neighbour and the entire sphere of human activity for miles around.



A Telephone with its Accessories on a Desk Top.

If you had time and could reckon up the moments you save with your telephone the figures would astonish you. The telephone adds hours to the working day of the business man and permits him to crowd more labour into a given time, though it is not so apparent now because telephones are a part of the commercial machine, and have lost their novelty. In town and country the telephone is an investment which pays "hands down," and if you have any volume of business to transact you should not be without one. If your works are scattered over a large acreage you can bring them close together by the intercommunication telephone. Messengers around a works are not to be tolerated in these days of the telephone.

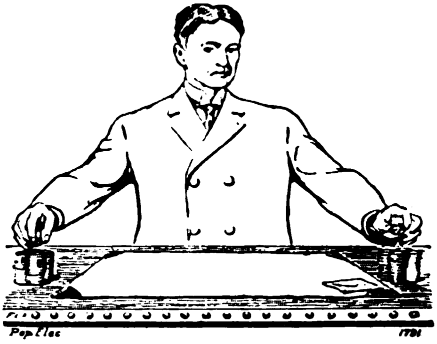


Figure it out.

When the gas works in the earth's interior will cease disturbing mortals on the surface.

* * *

Why risks from gas explosions are constantly incurred by people who *ought* to use electric light.

* * *

Where the average "commercial" would be without the telephone and the electric tramcar. (As a diversion figure out what he says when he can't get either.)

* * *

What weight of dust, soot, and ash you breathe from an atmosphere made filthy by thousands of chimneys.

* * *

How long the world would have waited for news of the Madrid bomb outrage if there had been no telegraph or telephone. (A large sheet of paper, please.)

* * *

What size grease spot your adipose tissue will make, if you don't use an electric fan these hot days.

* * *

How much superior the electric launch on the Thames is to the snorting, ——ing motor variety.

* * *

When we may expect to see electric omnibuses running in the streets of London and provincial towns.

Things you ought to Have.

You may always turn to these pages for information on the latest and most useful electrical devices. When you write for details always mention POPULAR ELECTRICITY.

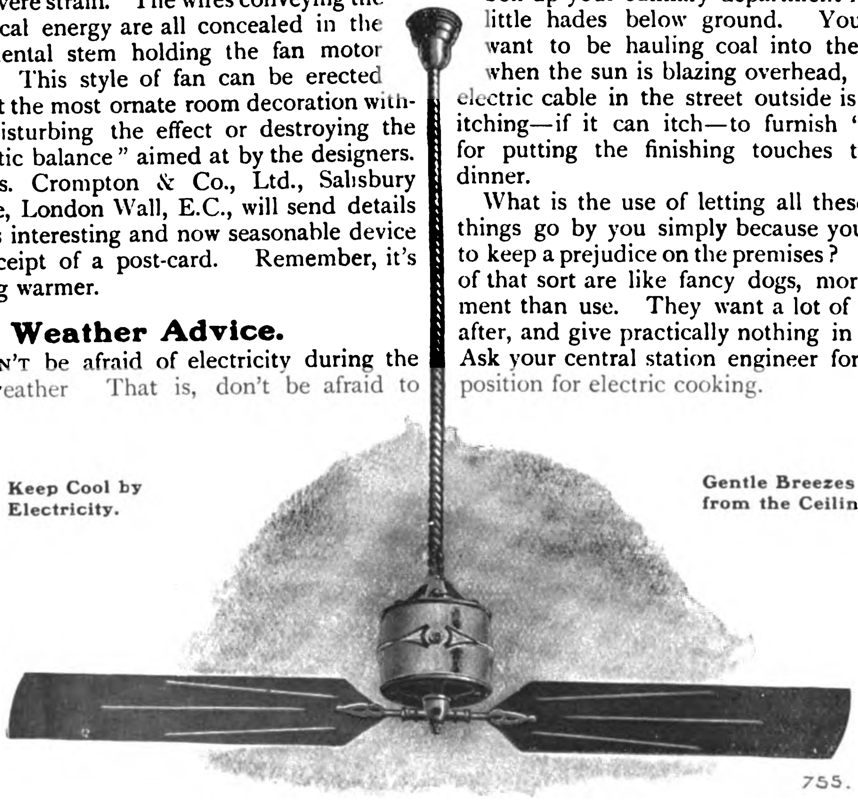
Ceiling Fans.

THE ceiling fan is essentially electrical in its conception and practical in realization. Cooling breezes generated above the heads of perspiring occupants of rooms are delightful to experience, and indeed are the quintessence of comfort. A fan hung from the ceiling like that shown on this page will distribute air evenly and without unpleasant draught in a large room. It moves very slowly, and therefore requires no attention, because its bearings are not subjected to any severe strain. The wires conveying the electrical energy are all concealed in the ornamental stem holding the fan motor body. This style of fan can be erected amidst the most ornate room decoration without disturbing the effect or destroying the "artistic balance" aimed at by the designers. Messrs. Crompton & Co., Ltd., Salisbury House, London Wall, E.C., will send details of this interesting and now seasonable device on receipt of a post-card. Remember, it's getting warmer.

Hot Weather Advice.

DON'T be afraid of electricity during the hot weather That is, don't be afraid to use it. Again, don't run away with the idea that because gas makes everything so desperately uncomfortable on hot days that electricity will do the same. A gas stove, for instance, is a positive abomination when the thermometer is at 92 in the shade. It is, of course, a great convenience, and heaps better than a coal fire, but it's many "blocks" behind electricity for cooking purposes. It is during the sweltering days that you can come to a full realisation of what electric cooking is. There is no need to box up your culinary department in some little hades below ground. You don't want to be hauling coal into the house when the sun is blazing overhead, and an electric cable in the street outside is simply itching—if it can itch—to furnish "juice" for putting the finishing touches to your dinner.

What is the use of letting all these good things go by you simply because you prefer to keep a prejudice on the premises? Things of that sort are like fancy dogs, more ornament than use. They want a lot of looking after, and give practically nothing in return. Ask your central station engineer for a proposition for electric cooking.



Keep Cool by Electricity.

Gentle Breezes from the Ceiling.

Electric Propeller Fan for hanging from the ceiling to give cooling breezes in hot weather.

An Electric Kettle for tea in the garden or on the terrace.

Afternoon Tea.

When the up-to-date hostess entertains her guests at tea, she brews the "cup that cheers" with water from an electric kettle. Spirit lamps are highly dangerous and have caused horrible deaths of careless users, and no sane person would think of putting a "gas" kettle on a modern tea table. This would be the height of folly, but there is no need for such risks to be run. The electric kettle is convenient, and—what is more important—safe, and these features justify the strong claims it has upon those who entertain and who have an electricity supply available. A neat stand will hold this dainty kettle, and as the illustration shows, make it an artistic addition to the most elaborate tea table. In summer days tea is taken under the trees on the lawn, but that does not matter if you have an electric kettle, because a thin coil of flexible wire will convey energy from the house, if inserted in a convenient plug socket. The kettle we illustrate on this page is made by the British Prometheus Company, and we shall be pleased to furnish fuller details on request.

Lampholder Fans.

If you turn to page 86 of this issue you will find a description and illustrations of a handy form of cooling device in the shape of an electric fan, to fit into an ordinary lampholder. It can be obtained from the National Telephone Co., Telephone House, Victoria Embankment, E.C.

Art in Fittings.

Electric light is specially adaptable to illuminating the most chaste art figures, and some of the loveliest designs have been produced to delight admirers of the beautiful. In a few lines we cannot describe the many charming things which are now purchaseable in this branch of art, but an illustration will make it clear that there are no limits to the production of any idea which may be held of a suitable fitting for hall and staircase use. The figure of a miner which we depict on this page is effective enough in the reproduction, but it does scant justice to the original, which is realistic in the extreme. When seen lighted at night the illuminating effect is that of a soft glow such as would be shed from a lantern. In the design of this class of fitting, Falk, Stadelmann & Co., Ltd., are much experienced, and will send full details on request to their London showrooms, Farringdon Road, E.C.

An Artistic Figure for Hall and Staircase Electric Lighting.

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